EXHIBIT A

Expert Report of Lisa A. Rodenburg, Ph.D.

City of Spokane v.
Monsanto Company, et al.

Lisa A. Rodenburg

Submitted by Lisa A. Rodenburg, Ph.D.
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Fingerprinting of PCB congener patterns in samples from the Spokane, WA area

Lisa A. Rodenburg

Qualifications

I am a Professor of Environmental Science at Rutgers, the State University of New Jersey. I have a BA in chemistry from Wittenberg University and a PhD in Environmental Engineering from the Johns Hopkins University. I have been studying PCBs since 1998 when I began a post-doctoral fellowship at Rutgers with Dr. Steven Eisenreich, a noted PCB expert. I have extensive experience measuring PCBs in environmental samples in an academic laboratory using methods similar to EPA methods 8082 and 1668, and in interpreting PCB data from these two methods.

I have pioneered the use of factor analysis, specifically Positive Matrix Factorization, to understand the sources of PCBs to complex ecosystems that may have multiple potentially responsible parties (PRPs) and display a variety of PCB weathering processes. I used the methods described here (analysis of data sets with the PMF2 software) to investigate several systems resulting in multiple peer-reviewed publications and reports, including:

- The Delaware River (air, water, sediment, and permitted discharges) with funding from the Delaware River Basin Commission and the New Jersey Department of Environmental Protection (Du and Rodenburg, 2007a; Du et al., 2008; Du et al., 2009; Rodenburg et al., 2010a; Praipipat et al., 2013; Praipipat et al., 2017).

- The New York/New Jersey Harbor (air, water, sediment, and permitted discharges) with funding from the Hudson River Foundation (Rodenburg et al., 2011; Rodenburg et al., 2012; Rodenburg and Ralston, 2017).

- The Green-Duwamish River (atmospheric deposition, water, sediment, biota, and storm water) with funding from the State of Washington in a project overseen by the US EPA (Rodenburg and Leidos, 2017b, a).

- The Portland Harbor Superfund Site (water and sediment) (Rodenburg et al., 2015c).

- The city of Chicago (atmospheric deposition) (Rodenburg and Meng, 2013).

- The Hanford Site in Hanford, Washington (biota) (Rodenburg et al., 2015a).

In these studies, I have identified PCB sources that are not related to Aroclors or other intentionally–produced commercial PCB formulations, including PCBs generated inadvertently during various chemical processes such as the production of pigments, as well as the dechlorination of parent PCB congeners (most likely arising originally from commercial formulations) by bacteria. As a result, I am recognized as an international expert in non-commercial PCB sources, having published several peer-reviewed papers on this subject

(Rodenburg et al., 2010b; Guo et al., 2014; Rodenburg et al., 2015b). I served as an expert witness on this subject for the State of Washington (Department of Ecology) at the August 2012 meeting of the Environmental Council of States. My research on this subject led to my appearances on Good Morning America in 2014 and news coverage in outlets such as Scientific American, Environmental Health Perspectives, Environmental Health News, and Yahoo! News.

My expertise on the subject of PCB sources and fate has been recognized by the Hudson River Foundation, where I serve as a member of their Science and Technical Advisory Committee for the New York/New Jersey Harbor & Estuary Program. I am currently an advisor to the Spokane River Regional Toxics Task Force (SRRTTF). I have also served on the Expert Panel advising the Delaware River Basin Commission on establishment of a Total Maximum Daily Load (TMDL) for PCBs in the Delaware River.

For additional qualification information, see my CV attached as Exhibit A.

Compensation

My general billing rate is $200 per hour. My rate for testimony is $300 per hour.

Testimony in Past 4 Years

City of Hartford, et al. v. Monsanto Company, et al. – February 7, 2018

City of San Diego, et al. v. Monsanto Company, et al. – June 14, 2019

Summary of opinions

In my expert opinion, commercial PCBs (Aroclors), and not byproduct PCBs, are the main sources of PCBs to all of the environmental compartments in and around the Spokane River and associated watershed for which we have data.

Through my analysis, as discussed throughout this report, I have developed the following opinions, discussed here by environmental compartment. In all compartments, Aroclors are the dominant source of PCBs. The following compartments were investigated using PMF (Positive Matrix Factorization):

- In surface water samples collected by the SRRTTF, commercial PCBs make up about 90% of the total PCBs present.
- In samples from the sewer system of the Spokane City WWTP, which includes both plant influent and CSOs, commercial PCBs on average make up over 95% of the total PCBs detected.
- In the water column, commercial PCBs make up about 90% of the total PCB mass on average.

- In tissue from fish caught in the Spokane River in the vicinity of the city of Spokane, commercial PCBs account for virtually all of the PCBs detected. Non-commercial PCBs make up less than 1% of the total PCBs detected.
- In stormwater samples from the city of Spokane, commercial PCBs comprise over 95% of total PCBs, on average.
- In groundwater at the Kaiser facility, commercial PCBs account for virtually all of the PCBs detected.
- In outfalls at the Kaiser facility, commercial PCBs make up about 98% of total PCBs.

The following compartments were investigated using MLR (Multiple Linear Regression):

- Two CSO samples were collected using a different method than other CSO samples and must be analyzed separately. In those samples, commercial PCBs made up over 99% of the total PCBs present.
- Twenty-three stormwater samples were collected using a different method than other stormwater samples and must be analyzed separately. In those samples, commercial PCBs made up over 95% of the total PCBs present.
- In eight samples of solids from storm drains and collection basins, commercial PCBs make up more than 95% of total PCBs on average.
- In treated effluent from the City of Spokane's WWTP, commercial PCBs made up more than 90% on average of total PCBs.
- In bulk atmospheric deposition samples collected in and near Spokane, Aroclors were the dominant sources of PCBs. The contribution of non-commercial PCBs to the atmospheric deposition was difficult to quantify due to probable blank contamination, but is certainly less than 50%.
- In samples of biofilm and caddis and mayfly larvae collected in the Spokane River, commercial PCBs make up about 90%, on average, of total PCBs.
- In river sediment from the Spokane River near Spokane, commercial PCBs were more than 95%, on average, of total PCBs.
- In groundwater from the GE facility, commercial PCBs account for virtually all PCBs detected.
- In samples from the Inland Empire Paper wastewater treatment facility, commercial PCBs comprised more than 80% of total PCBs on average.
- In surface water sampled using the CLAM device, commercial PCBs comprised about 90% of total PCBs.

In municipal products tested by the City of Spokane, Aroclor PCBs were sometimes present, indicating that not all PCBs detected in consumer products can be assumed to arise from non-commercial sources.

Introduction

Samples of a wide variety of environmental compartments in the Spokane, WA area were analyzed for this report. The purpose of this work was to examine the congener patterns in these samples in an attempt to determine whether the PCBs in these samples arose from Aroclors produced by Monsanto, and if so to quantify the fraction of the total PCBs in each sample that is attributable to Aroclors versus the fraction attributable to non-Aroclor sources.

As explained in more detail below, I used two types of analysis for this project: Positive Matrix Factorization (PMF) and Multiple Linear Regression (MLR). PMF is the primary technique used here, but for certain samples insufficient data required MLR analysis. For the following environmental compartments, I conducted a PMF analysis:

- Surface water
- Spokane City WWTP influent and CSOs
- Fish
- Stormwater
- Kaiser groundwater
- Kaiser outfalls

For the following environmental compartments, the quantity of data was not sufficient for PMF analysis, so these compartments were analyzed using Multiple Linear Regression (MLR):

- Two samples from CSOs measured using a DB5 column
- Twenty-three samples of stormwater measured using an SPB-octyl column
- Spokane City WWTP treated effluent
- Bulk Atmospheric Deposition
- Biofilm
- Sediment (including suspended particulates)
- Surface water CLAM (Continuous low-level aquatic monitoring) samples
- Groundwater from the GE plant
- Inland Empire Paper outfalls
- Storm drain solids
- Municipal products

These data have been collected under various Quality Assurance Project Plans (QAPPs). Data was obtained from two main sources. The first was the database provided by Baron and Budd. Version 20 was used for all analyses in this report. Data were blank corrected before being entered into this database. The second source was the SRRTTF, which provided various data in the form of Excel spreadsheets. This data underwent Quality Assurance checks. In each of the SRRTTF data sets, data was provided as "MEL amended" results, which were blank corrected. These MEL amended results were used for all analyses.

Background on PMF

The primary technique used here is factor analysis using Positive Matrix Factorization (PMF) (Paatero and Tapper, 1994). This approach has been used extensively in the environmental literature to investigate PCB sources by the author of this report (Du and Rodenburg, 2007b; Du et al., 2008; Rodenburg et al., 2010a; Rodenburg et al., 2011; Rodenburg et al., 2012; Praipipat et al., 2013; Rodenburg and Meng, 2013; Rodenburg et al., 2015a; Rodenburg et al., 2015c; Praipipat et al., 2017; Rodenburg and Ralston, 2017) and many other researchers (Magar et al., 2005; Bzdusek et al., 2006a; Bzdusek et al., 2006b; Soonthornnonda et al., 2011; Uchimiya et al., 2011; Saba and Su, 2013; Karakas et al., 2017).

PMF defines the sample matrix as product of two unknown factor matrices with a residue matrix:

$$X = GF + E \qquad (1)$$

The sample matrix (X) is composed of n observed samples and m chemical species. F is a matrix of chemical profiles of p factors or sources. The G matrix describes the contribution of each factor to any given sample, while E is the matrix of residuals. The PMF solution, i.e. G and F matrices, are obtained by minimizing the objective function Q through the iterative algorithm:

$$Q = \sum_{i=1}^{n}\sum_{j=1}^{m}(e_{ij} / s_{ij})^2 \qquad (2)$$

Q is the sum of the squares of the difference (i.e. e_{ij}) between the observations (X) and the model (GF), weighted by the measurement uncertainties (s_{ij}). Here we have used the PMF2 software of Paatero and Tapper (1994).

The advantage of the PMF approach is that it can quantify the fraction of a given congener that comes from Aroclor versus non-Aroclor sources, and it does not make the assumption that no weathering of the PCB fingerprints has taken place. Instead it produces fingerprints of congeners that co-vary and have been found to be present in most of the samples. The user can then compare these fingerprints to the Aroclor patterns to determine whether they are similar to the Aroclors. In the PCB source evaluation project in the Green-Duwamish River system in Washington State (Rodenburg and Leidos, 2017a), the Washington State Department of Ecology accepted the interpretation that when the agreement (R^2) between the fingerprint produced by the PMF program and a single Aroclor is greater than approximately 0.8, the factor was considered to represent an unweathered single Aroclor. When the agreement was not as good (i.e., R^2 between approximately 0.4 and 0.8), the factor was interpreted as representing a weathered Aroclor. US EPA oversaw this project and did not object to this interpretation.

There are two main disadvantages of the PMF approach. First, the PMF program cannot find a stable solution when the input data contains too many values that are below detection limit (BDL). For this reason, congeners (or chromatographic peaks) that are frequently not detected

are removed from the data set prior to analysis. Second, the PMF program performs best when there are at least as many samples as PCB congeners (or peaks) in the input data set. As a result, the PMF approach requires a large number of samples to be effective. It is possible to include more congeners (peaks) than samples in the input, but if the number of peaks exceeds the number of samples by too wide a margin, the PMF program will be unable to find a stable solution. As a result of these two limitations, not all of the 209 PCB congeners will be considered in the PMF analysis, and therefore some of the PCB mass will not be considered. In addition, all of the samples included in a single PMF model must have the same coelution pattern. (This issue is described in more detail in the section on Measurement of PCBs below.) This means that data collected on one GC column (such as the SPB-octyl column) can only be combined with data collected using another column (such as the SGE-HT8) by pre-processing the data to sum some congeners so that both data sets will use a common co-elution pattern. Information is lost in the process. Also, all of the samples in a single PMF analysis should come from a set of samples collected in the same region and environmental compartment (i.e. water, sediment, etc.) so that they will have congener patterns in common. For example, in this report, fish samples are not combined with storm water samples for PMF analysis.

All data analysis approaches require that the input data be processed in some way. As noted above, the PMF approach requires that some congeners be discarded from the PMF input. In the sections below, I have indicated how much of the PCB mass had to be discarded when constructing the PMF inputs. Typically the fraction discarded is much less than 10%. Construction of the PMF inputs also requires that a proxy value be used in place of a zero for a value that is below detection limit. To do so, the operator must have some knowledge of the detection limits for each measurement. For all data sets analyzed using PMF in this report, non-detect values were replaced with a random number between zero and the LOD. Further, the PMF approach requires the user to estimate the uncertainty associated with each measurement. Usually the uncertainties for concentrations that are detected are calculated on a congener-by-congener basis from the relative standard deviation of the surrogate recoveries for each congener. When surrogate recovery information is not available, we have used uncertainties from a different but similar data set. For example, surrogate recoveries were not available for water and sediment data from the Portland Harbor Superfund Site, so the uncertainty matrices from the Delaware River water and sediment were substituted, respectively (Rodenburg et al., 2015c). Concentrations that were not detected were assigned three times the base uncertainty.

Non-commercial fingerprints from other data sets

The approach of using PMF2 analysis to identify PCB sources has been used in many previous studies that can be used to estimate the minimum contribution of non-commercial PCB sources that can be detected using the PMF approach. Table 1 summarizes the contribution of non-commercial PCB sources to various data sets investigated by the author of this report. In all cases, fingerprints identified in these studies as 'non-commercial' met the criteria enumerated above.

Table 2 suggests that the PMF analysis approach is capable of detecting a non-commercial fingerprint when it contributes as little as 1.1% of the PCB mass in the data set. To the extent that the data set is representative of the compartment (water, sediment) as a whole, this percentage can be interpreted as the contribution of the non-commercial source to all the PCB sources for that compartment. In five of the sixteen cases in which a non-commercial PCB factor was identified, the contribution of the non-commercial factor was equal to or less than 2%, suggesting that this approach can routinely identify contributions at this level.

For the present analysis, we conclude that for compartments in which a non-commercial factor was not isolated by the PMF analysis (i.e. fish tissue and Kaiser outfall), the contribution of non-commercial PCBs to that compartment is less than the contribution detected for the Spokane city storm water (6.5%) with a high degree of certainty, and is 2% or less with a reasonable degree of certainty.

Table 1: Non-commercial PCB factors isolated in other studies and their contribution to the mass in the data set.

Location	Matrix	Contribution of factor associated with:		Reference
		PCB 11	PCB 209	
Delaware River	Water	5%	19%	(Du et al., 2008)
	Sediment	1.4%	61%	(Praipipat et al., 2013)
	permitted discharges*	6.7%	1.5%	(Rodenburg et al., 2010a)
NY/NJ Harbor	Water	2.4%	none	(Rodenburg et al., 2011)
Portland Harbor Superfund Site	Water	6.3%	none	(Rodenburg et al., 2015c)
	sediment	1.1%	none	
Green-Duwamish River	atmospheric deposition	9%	4%	(Rodenburg and Leidos, 2017a)
	sediment	1.5%	none	
	stormwater solids	2%	8%	
	stormwater	4%	6%	

*For permitted discharges, the contribution represents the contribution to the total *load* of PCBs discharged from all facilities in the data set to the river. Load is calculated as concentration times flow, so facilities with larger flows will represent a larger contribution to the total load.

Background on MLR

The second technique used in this report is Multiple Linear Regression (MLR), sometimes also called Partial Least Squares (PLS) regression. I compared the PCB congener fingerprints in the samples with those in the Aroclors as measured either by Rushneck et al. (2004) on an SPB-octyl gas chromatography column or by Pacific Rim Laboratories on an SGE-HT8 gas chromatography column. This technique conducts a MLR of the congener fingerprint of the sample (y) versus the Aroclor fingerprints (x's). A multiple linear regression was performed in which a congener pattern was calculated that represented a linear combination of the five main Aroclors:

$$C_f = aC_{1016} + bC_{1242} + cC_{1248} + dC_{1254} + eC_{1260} \quad (4)$$

where

C = concentration of the resolved factor (*f*) or individual Aroclor,
a, *b*, *c*, *d* and *e* = partial regression coefficients.

When any of the coefficients was zero or negative, that Aroclor was removed from the regression and the MLF was rerun. This approach follows the scheme outlined by Burkhard and

Weininger (1987) and more recently by Zhang and Harrington (2015). This approach has been widely used to determine PCB sources (Swackhamer and Armstrong, 1988; Verbrugge et al., 1991). MLR was conducted using the LINEST feature of Excel and/or via python code. Congener fingerprints were normalized such as that each congener/peak was expressed as a percent of the total fingerprint, with the sum of all congeners equal to 100%. For purposes of MLR, non-detects were set to zero, because in their measurements of the fingerprints of the Aroclors performed by Rushneck et al. (2004) via method 1668 and by Frame (1997) and Frame et al. (1996), non-detects were likewise set to zero and no information about detection limits was available.

In the PCB source evaluation project in the Green-Duwamish River system in Washington State (Rodenburg and Leidos, 2017a), the Washington State Department of Ecology accepted the interpretation that when the agreement (R^2) between a fingerprint and a single Aroclor is greater than approximately 0.8, the factor was considered to represent an unweathered single Aroclor. When the agreement was between approximately 0.4 and 0.8, the fingerprint was interpreted as representing a weathered Aroclor.

Measurement of PCBs

The congener-specific PCB data evaluated here were collected using U.S. Environmental Protection Agency (EPA) Method 1668, which was first published in 1999 and has undergone several revisions since then (EPA, 1999). The first version was Method 1668A, and subsequent minor revisions are denoted as 1668B, 1668C, and 1668D. There is relatively little difference between the various revisions, and data collected under different revisions are highly comparable and can generally be pooled and used together. Method 1668 uses a high-resolution mass spectrometer (MS) coupled with high-resolution gas chromatography (GC) to measure PCBs in any matrix. Chromatography is the science of separating a mixture into its individual components by injecting the mixture into a mobile phase, which then passes through a stationary phase. Some compounds in the mixture spend more time sorbed onto the stationary phase. Because these compounds spend more time not moving, they will emerge (elute) from the chromatographic system later. The amount of time a compound takes to travel through the chromatographic system is its retention time. In GC, the mobile phase is a gas (usually helium), and the stationary phase can be any one of a number of organic compounds chemically bonded to a stationary support. There are hundreds of GC columns commercially available. The primary mechanism causing some PCB congeners to be retained longer on any of these columns is their condensation on the stationary phase; therefore, the primary chemical property that determines the retention time is the compound’s vapor pressure. The type of stationary phase has a lesser, but still important, impact on the compound’s retention time.

There are 209 PCB congeners. A homologue group is a set of congeners that have the same number of chlorines. The MS used in Method 1668 can discern between different masses of the PCB molecule; therefore, congeners that have the same retention time but different masses (i.e., different homologues) can be quantified separately. The key difficulty in measuring PCBs is that, within a homologue group, there are often several congeners that are so similar in their

vapor pressure that they have essentially the same retention time; therefore, they cannot be quantified separately and can only be reported as the sum of multiple congeners. One of the primary goals when developing Method 1668 was to find a column that would resolve the 12 dioxin-like PCB congeners into 12 separate peaks, each with its own unique retention time, such that none of the 12 coelute with any other PCB congener. This would allow the results to be used to calculate a toxic equivalency quotient (TEQ) by multiplying the concentration of each dioxin-like congener by its corresponding toxic equivalency factor (TEF).

Separating the 12 dioxin-like congeners from all the others is difficult. Even after much effort, Method 1668 could only separate 10 of the 12 completely, with the 2 remaining dioxin-like congeners (PCB-156 and PCB-157) coeluting with each other using an SPB-octyl column. Fortunately, PCB-156 and PCB-157 have the same TEF; therefore, the calculation of the TEQ was not affected. However, the column that had been most commonly used for PCB analysis since the 1980s could separate PCB-156 and PCB-157 into 2 separate peaks, but it could not resolve all of the other 10 dioxin-like congeners. This column is referred to as DB-1 in Method 1668, but it is also referred to as DB-5, as well as a number of other names. The authors of Method 1668 allowed this column as an alternate. As written, Method 1668 requires the use of "[a]ny GC column or column system (2 or more columns) that provides unique resolution and identification of the Toxics for determination of a TEQPCB using TEFs...Isomers may be unresolved so long as they have the same TEF and response factor and so long as these unresolved isomers are uniquely resolved from all other congeners. For example, the SPB-octyl column…achieves unique GC resolution of all Toxics except congeners with IUPAC numbers 156 and 157. This isomeric pair is uniquely resolved from all other congeners and these congeners have the same TEF and response factor…The DB-1 column is optional and is capable of uniquely resolving the congener pair with IUPAC 156 and 157" (EPA, 1999).

To complicate matters further, SGE Analytical Science produces a column called the SGE-HT8, which is capable of resolving more congeners than the DB-5 and is more rugged than the SPB-octyl. This column is often used for PCB analysis by Method 1668, especially in the Spokane area.

As noted, there is no column that can separate all 209 congeners into 209 separate peaks. Some congeners will always coelute. The problem is that the coelution patterns are very different on the SPB-octyl, SGE-HT8, and DB-5 equivalent columns. Table 1 summarizes the most common coelution patterns, but differences can be observed depending on the lot and age of the GC column. These differences are usually minor for the SPB-octyl and DB-5 columns, but the coelution patterns can vary substantially on the SGE-HT8 column.

As Table 2 demonstrates, if the goal is to mix data collected on the different types of columns into a single data set for analysis, the concentrations reported for a variety of congeners must sometimes be summed. One example is PCB-85. On the DB-5 column, six separate reported concentrations must be summed to equal the sum of three reported concentrations from the SPB-octyl column, which yields a single concentration representing the sum of PCB congeners 85, 86, 87, 97, 108, 112, 116, 117, 119, and 125. Information is lost. As a result, while the DB-5

column reports the 209 PCBs in about 168 chromatographic peaks, and the SPB-octyl column reports the 209 congeners in about 159 peaks, a data set in which SPB-octyl and DB-5 data have been combined will contain only about 128 peaks. A data set in which all three types of columns have been used will contain only about 122 peaks after they are composited. For these reasons, I avoided compositing data whenever possible.

Table 2. PCB Congener Coelution Patterns on the DB-5 (or equivalent), SGE-HT8, and SPB-octyl GC Columns. Reproduced from (Rodenburg and Leidos, 2017b).

DB-5	SGE-HT8	SPB-octyl
PCB-4+10	PCB-4	PCB-4
	PCB-10	PCB-10
PCB-5+8	PCB-5+8	PCB-5
		PCB-8
PCB-7+9	PCB-7	PCB-7
	PCB-9	PCB-9
PCB-12+13	PCB-12+13	PCB-12+13
PCB-16+32	PCB-16	PCB-16
	PCB-32	PCB-32
PCB-18	PCB-18	PCB-18+30
PCB-30	PCB-30	
PCB-20+21+33	PCB-20+33	PCB-20+28
PCB-28	PCB-21	PCB-21+33
	PCB-28	
PCB-24+27	PCB-24	PCB-24
	PCB-27	PCB-27
PCB-26	PCB-26	PCB-26+29
PCB-29	PCB-29	
PCB-40	PCB-40+57	PCB-40+41+71
PCB-41+64+71+72	PCB-41	PCB-57
PCB-57	PCB-64+72	PCB-64
	PCB-71	PCB-72
PCB-42+59	PCB-42	PCB-42
PCB-43+49	PCB-43+49	PCB-43
PCB-44	PCB-44	PCB-44+47+65
PCB-47	PCB-47+48	PCB-48
PCB-48+75	PCB-52+69	PCB-49+69
PCB-52+69	PCB-49	PCB-52
PCB-62	PCB-62	PCB-59+62+75
PCB-65	PCB-65+75	
PCB-45	PCB-45	PCB-45+51
PCB-51	PCB-51	

DB-5	SGE-HT8	SPB-octyl
PCB-50	PCB-50	PCB-50+53
PCB-53	PCB-53	
PCB-56+60	PCB-56	PCB-56
	PCB-60	PCB-60
PCB-61+70	PCB-61	PCB-61+70+74+76
PCB-66+76	PCB-66	PCB-66
PCB-74	PCB-70	
	PCB-74	
	PCB-76	
PCB-83	PCB-83+109	PCB-83+99
PCB-85+116	PCB-85	PCB-85+116+117
PCB-86	PCB-86+97+117	PCB-86+87+97+108+119+125
PCB-87+117+125	PCB-87+115	
PCB-97		
PCB-99	PCB-99	
PCB-107+109	PCB-107+108	PCB-107+124
PCB-108+112		PCB-109
PCB-110	PCB-110	PCB-110+115
PCB-111+115	PCB-111	PCB-111
PCB-119	PCB-112+119	PCB-112
	PCB-116+125	
PCB-124	PCB-124	
PCB-84+92	PCB-84	PCB-84
	PCB-92	PCB-92
PCB-88+91	PCB-88	PCB-88+91
	PCB-91	
PCB-93	PCB-93+98+102	PCB-93+95+98+100+102
PCB-95+98+102	PCB-95	
PCB-100	PCB-100	
PCB-90+101	PCB-90	PCB-90+101+113
PCB-113	PCB-101	
	PCB-113	
PCB-105	PCB-105+127	PCB-105
PCB-127		PCB-127
PCB-106+118	PCB-106	PCB-106
	PCB-118	PCB-118
PCB-128+162	PCB-128	PCB-128+166

DB-5	SGE-HT8	SPB-octyl
PCB-166	PCB-162	PCB-162
	PCB-166	
PCB-129	PCB-129	PCB-129+138+160+163
PCB-138+163+164	PCB-138	PCB-158
PCB-158+160	PCB-158	PCB-164
	PCB-160	
	PCB-163+164	
PCB-132+161	PCB-132+161	PCB-132
		PCB-161
PCB-133+142	PCB-133	PCB-133
	PCB-142	PCB-142
PCB-135	PCB-135	PCB-135+151+154
PCB-151	PCB-151	
PCB-154	PCB-154	
PCB-136	PCB-136+148	PCB-136
PCB-148		PCB-148
PCB-134+143	PCB-134	PCB-134+143
PCB-139+149	PCB-139+149	PCB -139+140
PCB-140	PCB-140	PCB-146
PCB-146+165	PCB-143	PCB-147+149
PCB-147	PCB-146	PCB-165
	PCB-147	
	PCB-165	
PCB-153	PCB-153	PCB-153+168
PCB-168	PCB-168	
PCB-156	PCB-156	PCB-156+157
PCB-157	PCB-157	
PCB-171	PCB-171	PCB-171+173
PCB-173	PCB-173	
PCB-180	PCB-180	PCB-180+193
PCB-193	PCB-193	
PCB-182+187	PCB-182+187	PCB-182
		PCB-187
PCB-183	PCB-183	PCB-183+185
PCB-185	PCB-185	
PCB-196+203	PCB-196	PCB-196
	PCB-203	PCB-203

DB-5	SGE-HT8	SPB-octyl
PCB-197	PCB-197	PCB-197+200
PCB-200	PCB-200	
PCB-198	PCB-198	PCB-198+199
PCB-199	PCB-199	

Congeners that do not coelute on any column are not shown.

GC = Gas chromatography.

PCB = Polychlorinated biphenyl.

Non-Aroclor PCB congeners

The primary focus of this analysis is to identify PCBs that arise from sources other than Aroclors (or other commercial PCB formulations). How can this be accomplished using PMF? In order for a factor that is isolated by PMF to be identified as a "non-Aroclor" source, it must fulfill three criteria. First, it should not resemble any of the Aroclors. As noted above, in the PCB source evaluation project in the Green-Duwamish River system in Washington State (Rodenburg and Leidos, 2017a), the Washington State Department of Ecology accepted the interpretation that when the agreement (R^2) between the fingerprint produced by the PMF program and a single Aroclor is greater than approximately 0.8, the factor was considered to represent an unweathered single Aroclor. When the agreement was not as good (i.e., R^2 between approximately 0.4 and 0.8), the factor was interpreted as representing a weathered Aroclor.

The second criteria is that when the agreement between the Aroclor and the factor (R^2) is less than 0.4, the differences between the Aroclor and the factor cannot be explained by any known weathering phenomenon. Weathering processes include partitioning between air, water, or sediment as well as metabolism by biota or bacteria. Often PMF generates factors from biota that are not similar to the Aroclors, but the differences conform with current knowledge about the metabolism of PCB congeners via the cytochrome P-450 pathway (Boon et al., 1997). Similarly, in anaerobic environments, bacteria are able to remove one or more of the chlorines from the PCB molecule, turning one PCB congener into another. This process is well understood, and produces a characteristic congener pattern (Bedard, 2003; Rodenburg et al., 2010a; Rodenburg et al., 2012; Rodenburg et al., 2015c).

The third criteria is that non-Aroclor source fingerprints will probably contain congeners that are known to be associated with non-Aroclor sources. For this reason, in order to identify non-Aroclor PCB sources, it is important to include PCB congeners in the PMF input data sets that are known to be associated with non-Aroclor sources.

The sources of PCBs that are not associated with commercial formulations that have been identified in environmental samples include pigments (Du et al., 2008; Rodenburg et al., 2010a; Rodenburg et al., 2010b; Rodenburg et al., 2011; Rodenburg et al., 2015c) and silicone products (Rodenburg and Leidos, 2017a). A variety of PCB congeners that occur in the Aroclors are also sometimes found in non-Aroclor sources such as pigments. For example, (Hu and Hornbuckle, 2009) using an SPB-octyl column identified 47 peaks containing 67 PCB congeners in commercial paint pigments. Note that this does not necessarily imply that all 67 congeners were present in the pigments. When congeners coelute (such as, for example, the coeluting group of PCBs 86+87+97+109+125) it is possible that only one of the congeners is actually contained in the pigment. Nevertheless, in these pigments, (Hu and Hornbuckle, 2009) found congeners such as PCB 52, which is present in all of the Aroclors tested by Rushneck et al. (2004) and is most abundant in Aroclor 1248, where it constitutes about 7.1% of the Aroclor by weight.

The congeners known to arise only from non-Aroclor sources are PCBs 11 (from pigments) and 68 (from silicone rubber). PCB 11 is virtually absent in the Aroclors, but has been shown to be produced in advertently during the synthesis of some organic pigments (King et al., 2002; Litten et al., 2002; Hu and Hornbuckle, 2009; Rodenburg et al., 2010b). As a result, PCB 11 is present in various consumer products that have printed designs on them or their packaging (Rodenburg et al., 2010b; Guo et al., 2014; Stone, 2014; Rodenburg et al., 2015b), and can be released from these products into environmental compartments including air, storm water, surface water, sediment, and fish tissue (King et al., 2002; Litten et al., 2002; Choi et al., 2008; Du et al., 2008; Du et al., 2009; Rodenburg et al., 2010b; Rodenburg et al., 2011; Praipipat et al., 2013; Rodenburg et al., 2015a; Rodenburg and Ralston, 2017). PCB 11 was included in all of the data sets analyzed in this report.

PCB 68 is also virtually absent in the Aroclors but is present in silicone rubber that used 2,4-dichlorobenzoyl peroxide as a curing agent (Perdih and Jan, 1994; Anezaki and Nakano, 2015; Herkert et al., 2018). As a result, it can be present in environmental samples as an artifact (contamination) when silicone rubber tubing is used to collect the sample (Greyell and Williston, 2018). Herkert et al. (2018) have argued that PCB 68 can be present in polyester resins which have been cured using 2,4-dichlorobenzoyl peroxide. Use of 2,4-dichlorobenzoyl peroxide is typically associated with PCBs 44+47+65 and 45+51 along with PCB 68. Unfortunately, 44+47+65 and 45+51 are also found in the Aroclors (Rushneck et al., 2004), and they can also be markers for dechlorination of Aroclor PCBs by bacteria (Bedard and May, 1996; Magar et al., 2005; Bedard et al., 2006; Bzdusek et al., 2006a; Fagervold et al., 2007; Rodenburg et al., 2010a).

Other congeners are almost always associated with non-Aroclor sources. PCBs 206, 208, and 209 can be produced during the synthesis of some organic (Hu and Hornbuckle, 2009) and inorganic pigments (Gamboa et al., 1999; Du et al., 2008; Praipipat et al., 2013; Rodenburg and Ralston, 2017). Although these three congeners are mostly absent in the five main Aroclors (1016, 1242, 1248, 1254, and 1260), comprising a maximum of 0.9% of PCBs in Aroclor 1260, they are present in some of the rare Aroclors. In Aroclor 1268, they comprise 51% of total PCBs

(Rushneck et al., 2004). PCB 209 was reportedly present in Aroclors 1270 and 1271 (Hermanson et al., 2016), although Rushneck et al. (2004) did not measure the congener fingerprints of these Aroclors. In some locations, PCB 209 is clearly associated with commercial PCB production. For example, PCB 209 was found to be the dominant congener in some samples of soil, tree bark, and house dust collected near the former Monsanto PCB manufacturing facility in Sauget, IL (Stratton and Sosebee, 1976; Gonzalez et al., 2011; Hermanson et al., 2016). In contrast, in some places, the presence of PCB 209 is clearly associated with pigments. For example, in the Delaware River, a PMF-generated factor dominated by PCBs 206, 208, and 209 comprises 61% of the PCB mass in the sediment (Praipipat et al., 2013) and we are reasonably certain that it arose primarily from a facility in Edgemoor, Delaware that manufactured titanium dioxide via a process that is known to produce PCBs (Gamboa et al., 1999).

PMF results

Surface water

Summary: About 90% of PCBs in the surface water of the Spokane River come from Aroclors. The PMF-generated factor that is dominated by PCB 11 accounts for about 10% of the PCBs in the Spokane River.

Matrix analyzed: 191 samples, 68 peaks. About 10% of the PCB mass is lost during the blank correction process (see below). These 68 peaks represent 92.4% of the PCB mass remaining after blank correction, i.e. 7.6% of the mass is lost when congeners are discarded because they were not detected in enough samples to be included in the PMF input. This data was collected by the SRRTTF during 2014-2018 and provided by the SRRTTF via multiple spreadsheets.

Blank correction: Because the concentrations of PCBs in the surface waters of the Spokane River are relatively low (around 200-400 pg/L) and the concentrations in the blanks are around 88 pg/L, blank correction of this data is important. During 2018, I conducted a study funded by the SRRTTF to determine the optimal procedures for blank correction using the surface water data from 2014-2017 because the 2018 data was not yet available (Rodenburg, 2019). This study concluded that censoring the data at one times the batch-specific blank concentration was the most appropriate method. (Censoring means designating concentrations that are less than the concentration in the blank as non-detects. The other widely used method of blank correction is subtraction, in which the mass in the blank is subtracted from the mass in the sample, and if the results is equal to or less than zero, the concentration is designated at non-detect.) This study also concluded that PCBs from non-commercial sources (specifically PCBs from pigment, peroxide-cured silicone, and uncured silicone) were responsible for about one-third of the PCBs in the blanks, with the other two-thirds coming from Aroclors. Blank correction resulted in the fingerprints of PCBs from the two types of silicone to be undetectable in the water column data. For this analysis, SRRTTF provided the data already censored at one times the blank concentration.

Detection limits: Detection limits were usually provided. For the small number of samples for which LODs were not available, they were inferred from the LODs provided for congeners with the same molecular weight.

Uncertainty matrix: Uncertainties were calculated from the provided surrogate recoveries.

Samples included: All surface water samples from the Spokane River were included in the data matrix, as well as 15 samples from Hangman Creek.

Results: The results were virtually identical to those described in the blank study report (Rodenburg, 2019), i.e. five factors were isolated with four resembling Aroclors and the one dominated by PCB 11. SurfW 2 resembled Aroclor 1016 (R2 = 0.67). SurfW 3 resembled Aroclor 1248 (R2 = 0.75). SurfW 4 resembled Aroclor 1254 (R2 = 0.92), and SurfW 5 resembled Arolcor 1260 (R2 = 0.78).

SurfW 1 was dominated by PCB 11 (79% of the fingerprint). Even when PCB 11 was removed from the correlation, the best match between this factor and an Aroclor was 1242 with an R2 value of just 0.1. Therefore this factor did not resemble any Aroclor and it presumably arises from non-commercial sources. SurfW 1 accounts for 10.1% of PCBs in this data set. The abundance of this factor varies by location as shown in figure 1.

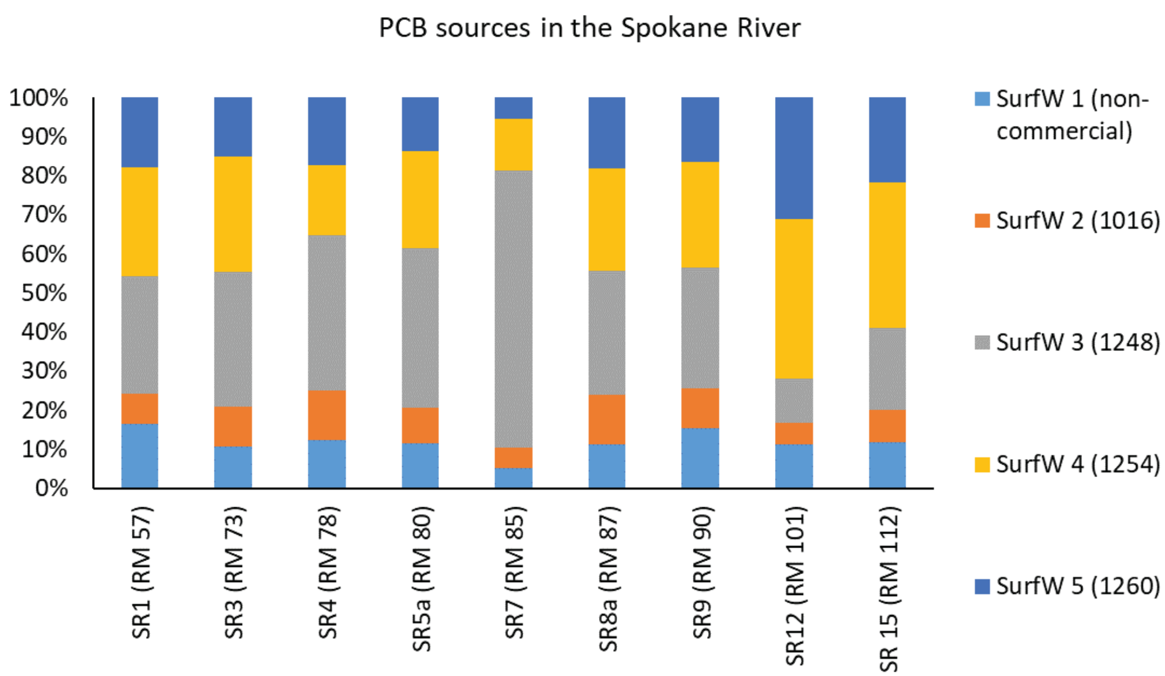

Figure 1. PCB sources to the Spokane River surface water by sampling location. River flow is from right to left, where SR15 is the outlet to Lake Coeur D'Alene and SR1 is below Nine Mile Dam. River miles (RM) are approximate.

Spokane City WWTP influent and CSO samples

Summary: More than 95% of the PCBs in the Spokane City WWTP influent and CSO samples arise from Aroclors. The PMF model generated a factor that contains some PCB 11, but this factor also resembled a mix of weathered Aroclors, suggesting that it represents a mixture of Aroclors and non-commercial PCBs. I estimate that non-commercial PCBs contribute less than 5% of the PCBs to the City wastewater influent and CSOs.

Matrix analyzed: 236 samples, 83 peaks. These peaks represent 98.6% of the PCB mass. Samples were from StudyIDs CityOfSpokaneWW (223 samples collected from 2009 to 2019), SRUW-Spokane (12 samples collected from 2009-2011), and DSER0010 (one sample from 2004). This data was provided in version 20 of the Baron and Budd database.

Samples included: Two samples from CSOs were not included in the PMF data set because they were analyzed using a DB5 column. These are analyzed separately via MLR under the section on MLR.

Blank correction: Blank correction was performed before this data was entered into the Baron and Budd v. 20 database.

Detection limits: Detection limits were usually provided. For the small number of samples for which LODs were not available, they were inferred from the LODs provided for congeners with the same molecular weight.

Uncertainty matrix: Uncertainties were calculated from the provided surrogate recoveries.

Results: The PMF analysis generated five factors. Four of the five factors resembled Aroclors. CityWW 1 strongly resembled a 50/50 mixture of Aroclors 1242 and 1248 (R2 = 0.92). CityWW 3 strongly resembled Aroclor 1254 (R2 = 0.82), CityWW 4 resembled a mixture of Aroclors 1254 and 1260 (R2 = 0.82). CityWW 5 resembled Aroclor 1254 (R2 = 0.74).

PCB 11 explained 12% of CityWW 2. The remainder of this factor resembled a mixture of Aroclors 1016, 1254, and 1260 (R2 = 0.63). This factor therefore represents a mixture of weathered Aroclors and non-commercial PCB sources. One way to interpret this R2 value is to say that Aroclor PCBs explain 63% of this fingerprint. This factor is responsible for 13% of the mass of PCBs in this data set. Since the majority of the PCBs in this factor arise from Aroclors, the fraction of PCBs in the data set that arise from non-commercial sources is less than this 13%. The minimum fraction of non-commercial PCBs in this fingerprint is 12% (the contribution from PCB 11) and the maximum is 37% (i.e. 100% minus the 63% arising from Aroclors). Thus the non-commercial contribution to the PCBs in the Spokane City wastewater influent and CSOs ranges from 1.6% (13% of mass times PCB 11's 12% of the fingerprint) to 4.8% (13% of mass times 37% the fingerprint not explained by Aroclors).

Fish tissue

Summary: PCBs in the fish of the Spokane River arise almost entirely (more than 99%) from Aroclors. The PMF model does not identify a fingerprint that is dominated by a non-commercial PCB congener.

Matrix analyzed: 105 samples, 104 peaks. These peaks represent 99.9% of the PCB mass. This data was from the following studyIDs:

- mifr0003 (4 samples collected in 2016)
- BERA0011 (10 samples collected in 2014)
- RJAC002 (15 samples collected in 2001)
- DSER0010 (15 samples collected in 2003-2004)
- WSTMP12 (36 samples collected in 2012)
- WSTMP03T (25 samples collected in 2003)

Samples included: A total of 118 samples of tissue were available. Thirteen of these were excluded from the PMF input because they were outside of the study area. Nine of these thirteen were from hatcheries.

Blank correction: Blank correction was performed before this data was entered into the Baron and Budd v. 20 database.

Detection limits: Detection limits were usually provided. For the small number of samples for which LODs were not available, they were inferred from the LODs provided for congeners with the same molecular weight.

Uncertainty matrix: Uncertainties were calculated from the provided surrogate recoveries.

Results: The PMF analysis produced six factors. Five of these six strongly resembled either a single Aroclor or a mixture of Aroclors with R2 values greater than 0.67. Fish 4 was a very weathered fingerprint. It resembles a mixture of Aroclors 1248, 1254, and 1260 (R2 = 0.46). It was dominated by PCBs 61+70+74+76, 66, 83+**99**+109, **85**+86+87+97+107+108+110+**115**+116+**117**+**119**+124+125, 105+**127**, 118, 129+**138**+160+**163**+164, **153**+**168**, and **180**+**193**. The congeners shown in bold in this list belong to groups I and II (least metabolizable) of the classification scheme devised by Boon et al. (Boon et al., 1989; Boon et al., 1997). Because these congeners are not readily metabolized by the fish, they tend to dominate in congener patterns derived from fish tissue. In our recent publication on PCB congener patterns in biota (Rodenburg and Delistraty, 2019), we noted that the ratio of 147+149 to 153+168 could be used as an indicator of the degree of metabolism of the PCB mixture. In the present data set, 147+149 was combined with 139 and 140. Therefore 139+140+147+149 represents a group of congeners that are readily metabolized, while 153+168 are not. The ratio of (139+140+147+149)/(153+168) is close to 1 in the five main Aroclors (ranging from 0.99 in Aroclor 1260 to 1.16 in Aroclor 1248). In the fish 4 factor, this ratio is 0.07, indicating extensive metabolism.

PCBs from non-commercial source are negligible in the fish tissue. PCB 11 was not detected in 48 of the 105 samples of fish. PCB 11 constituted a maximum of 0.4% of the sum of PCBs in these samples (non-detects set to zero). PCB 209 was not detected in 23 of the 105 samples. PCB 209 comprised a maximum of 0.2% of the sum of PCBs in these samples (non-detects set to zero).

Spokane Stormwater

Summary: PCBs in the stormwater arise primarily from Aroclors. The PMF analysis does not generate a factor that is dominated by non-commercial PCBs. PCBs 11 and 209 make up about 1% of total PCBs in the stormwater.

Matrix analyzed: The stormwater input matrix included 106 samples from the following studyIDs:

- CityOfSpokaneWW (41 samples collected from 2012-2016)
- SRUW-Spokane (35 samples collected from 2009-2011)
- BRWA0004 (30 samples collected in 2007)

Ninety-one PCB peaks were included in the PMF input. These peaks contained 98.2% of the PCB mass detected across all peaks/samples.

Samples included: Thirteen samples from studyID BRWA0004 were not included in the PMF input because less than 10 PCB peaks were detected in them. A further 23 samples were not included in the PMF input because they were analyzed using an SPB-octyl column. These are discussed below in the section on MLR.

Blank correction: Blank correction was performed before this data was entered into the database.

Detection limits: Detection limits were usually provided. For the small number of samples for which LODs were not available, they were inferred from the LODs provided for congeners with the same molecular weight.

Uncertainty matrix: Uncertainties were calculated from the provided surrogate recoveries.

Results: Five factors were isolated from the PMF analysis. Because most of these samples were analyzed using an SGE-HT8 column, I used the Aroclor patterns from Pacific Rim laboratories to determine whether the PMF-derived factors resembled Aroclors. StormW 1 resembled Aroclor 1242 (R2 = 0.67). StormW 2 resembled Aroclor 1254 (R2 = 0.86). StormW 5 resembled Aroclor 1260 (R2 = 0.87). StormW 4 and StormW 5 somewhat resembled Aroclors. The best-fit profiles for these two factors as a mixture of Aroclors resulted in R2 values of 0.34 for StormW 4 and 0.49 for StormW 5. PCB 11 comprised 4.3% of StormW 4 and 3.2% of StormW 5. These are not particularly high percentages. Other congeners that are sometimes associated with non-commercial PCBs sources are not very abundant in these two factors. For

example, PCB 35 is less than 0.1% of either StormW 4 or StormW 5. Similarly, PCB 209 is less than 1% of each factor. The ratio of PCBs 139+149 (readily metabolizable) to PCBs 153+168 (recalcitrant) is about 1.2 in the Aroclors, but is 0.57 in StormW 4 and is a miniscule 0.0001 in StormW 3. This indicates extensive metabolic weathering of these two factors. This might indicate the presence of feces in the stormwater, possibly from wildlife or pets. Regardless, there is little indication that these fingerprints represent non-commercial sources. More likely, they represent highly weathered Aroclors. PCB 11 comprises 0.8% of total PCBs in these stormwater samples and PCB 209 comprises 0.2% (non-detects set to zero). Thus the total contribution of non-commercial PCBs in the stormwater is about 1%.

Kaiser groundwater

Summary: PCBs in the groundwater at the Kaiser plant arise virtually exclusively from Aroclors. There is evidence of microbial dechlorination of PCBs occurring in the groundwater.

Matrix analyzed: The Kaiser groundwater input matrix included 166 samples and 70 PCB peaks. Most of this data was provided by the SRRTTF. Ten samples of groundwater collected in 2010 were obtained from the Baron and Budd database version 20. These peaks contained 99.1% of the PCB mass detected across all peaks/samples.

Samples included: Sixty-two samples were excluded because less than 30 congeners were detected in them. A further six samples marked "River @ Pump House" were not included because they represented river water, not groundwater.

Blank correction: I manually blank corrected this data by censoring at one times the batch-specific blank concentration.

Detection limits: Detection limits were usually provided. For the small number of samples for which LODs were not available, they were inferred from the LODs provided for congeners with the same molecular weight.

Uncertainty matrix: Uncertainties were calculated from the provided surrogate recoveries.

Results: The PMF program isolated four factors from the Kaiser groundwater data set. KaiserGW 3 resembled Aroclor 1248 (R2 = 0.71) and is responsible for 62% of the mass in the data set. KaiserGW 4 strongly resembled Aroclor 1254 (R2 = 0.96) and is responsible for 7% of the mass in the data set. The other two factors show evidence of microbial dechlorination of PCBs occurring in the groundwater. Some strains of anaerobic bacteria can remove chlorines from PCBs, resulting in PCB congeners with fewer chlorines (Brown et al., 1987). This process appears to occur in groundwater (Rodenburg et al., 2015c). Thus it is not surprising that it may be happening in the groundwater at the Kaiser site. KaiserGW 1 and KaiserGW2 both contain elevated levels of PCBs known to be products of dechlorination, particularly PCBs 19, 44+47+65 and 45+51. These two factors contain less than 0.1% each of PCBs 11 and 209, indicating that they are unlikely to come from non-commercial sources. PCB 68 was detected in only 35 of the

166 samples included in the PMF input. PCB 11 is about 0.01% of total PCBs in the Kaiser groundwater, and PCB 209 is about 0.001%.

Kaiser outfalls

Summary: Measurements of PCBs in the effluent from the Kaiser treatment plant appear to be impacted by a sampling artifact related to the use of silicone rubber tubing during sampling in one study. When steps are taken to account for this artifact, PCBs in the effluent arise overwhelmingly from Aroclors. Non-commercial PCBs make up about 2% of total PCBs in the Kaiser effluent.

Matrix analyzed: The Kaiser outfall input matrix included 225 samples from the following studyIDs:

- SGOL005 (two samples from 2001)
- SGOL001 (four samples from 2000)
- KaiserWWTP (142 samples from 2007-2011)
- DSER0010 (seven samples from 2003-2004)
- EffluentE120142015 (52 samples from 2014-2015)
- SRRTTF-2014 (four samples from 2014)
- SRRTTF-2015 (four samples from 2015)
- SRRTTF-2018 (ten samples from 2018)

Eighty-three PCB peaks were included in the PMF input. These peaks contained 99.1% of the PCB mass detected across all peaks/samples.

Samples included: All available samples were included in the PMF input.

Blank correction: Blank correction was performed before this data was entered into the Baron and Budd v 20 database.

Detection limits: Detection limits were usually provided. For the small number of samples for which LODs were not available, they were inferred from the LODs provided for congeners with the same molecular weight.

Uncertainty matrix: Uncertainties were calculated from the provided surrogate recoveries.

Results: Interpreting the results from the Kaiser effluents is complicated by the fact that the data appear to be impacted by a sampling artifact related to the use of silicone rubber tubing for sampling in studyID EffluentE120142015. PCB 68 is used as a marker for silicone rubber contamination because it is virtually absent in the Aroclors. In samples from studyIDs SGOL005 and SGOL001, PCB 68 is never detected. In samples from studyID KaiserWWTP, PCB 68 is detected in just eight of 134 samples included in the PMF input. In these eight samples, the maximum amount of PCB 68 is 0.15% of the sum of PCBs (non-detects set to zero). In contrast,

PCB 68 is detected in all 52 of the samples from studyID EffluentE120142015, and ranged from 0.9% to 3.6% of the sum of PCBs. PCB 68 is also detected in 14 of the 18 samples from the various SRRTTF studyIDs. These are the same studies that collected the data for the surface water analysis discussed above. As I noted in the section of surface water, blank correction of those studies is important. Blank correction of data in the Baron and Budd database was performed prior to the inclusion of the data in the database. It appears that this level of blank correction may have been insufficient to remove the influence of silicone rubber on the EffluentE120142015 samples.

PMF analysis of the full data set generated seven factors. Five of these seven could be described either as a single Aroclor or a mixture of Aroclors with R2 values ranging from 0.71 to 0.92. Kaiser outfall 4 was dominated by PCBs 4 and 19, which are characteristic end products of the microbial dechlorination of Aroclor-type PCBs (Brown et al., 1987). Therefore Kaiser outfall 4 represents an advanced stage of microbial dechlorination of PCBs, which is believed to be occurring in the groundwater at the Kaiser plant (see section on Kaiser groundwater, above).

In systems where bacteria are/were dechlorinating PCBs, it is common to see second dechlorination signal that is dominated by PCBs 44+47+65 and 47+51 (Bzdusek et al., 2006b; Rodenburg et al., 2010a), and indeed these congeners were seen in the Kaiser groundwater samples. Because these congeners have four chlorines, while PCB 4 has two and PCB 19 has three, the signal dominated by 44+47+65 and 45+51 has been called the 'partial' dechlorination factor (Rodenburg et al., 2010a). Kaiser outfall 5 may represent this partial dechlorination signal, because 44+47+65 makes up 18% of this fingerprint and 45+51 makes up 9%. However, PCB 68 is also found in this factor at 7%.

In order to determine whether Kaiser outfall 5 represents the dechlorination of Aroclor PCBs or silicone rubber contamination, I analyzed a smaller data set containing the same 83 PCB peaks and the 173 samples from all studyIDs except EffluentE120142015. This smaller data set generated seven factors. Each had a nearly perfect match in the solution from the larger data set. The R2 values for these matches were greater than 0.91 for all but Kaiser outfall 5, for which the R2 value was 0.70. One reason for the lower R2 value was that the fifth factor from this smaller data set contained very little PCB 68 (0.1%) while Kaiser outfall 5 contained 7% PCB 68. This fifth factor continues to contain high contributions from PCBs 44+47+65 and 45+51. This suggests that Kaiser outfall 5 represents a mixture of PCBs from silicone rubber and from the partial dechlorination occurring in the groundwater.

I have concluded that the PCB 68 found in the Kaiser outfall samples from studyID EffluentE120142015 was a result of contamination during sampling. Further, I conclude that the PCBs 44+47+65 and 45+51 in the outfall samples arose from the microbial dechlorination of Aroclor PCBs. I reach this conclusion based on the following lines of evidence. First, PCB 68 was only found in abundance in one of the eight studies. Other studies that collected water samples during the same years did not find significant amounts of PCB 68. Second, microbial dechlorination of PCBs is/was occurring at the site, as shown by the presence of the advanced dechlorination factor (Kaiser outfall 4). Third, when the samples from studyID

EffluentE120142015 are excluded, the PMF analysis produces a factor that contains high proportions of 44+47+65 and 45+51 but very little PCB 68. This suggests that 44+47+65 and 45+51 are important and abundant congeners in the outfall even when PCB 68 is not present and even when different sampling procedures were used. Third, other studies have demonstrated that when PCBs are being dechlorinated by bacteria, two dechlorination fingerprints are observed, one dominated by PCB 4 and 19 (as in Kaiser outfall 4) and a second that is dominated by PCB 44+47+65 and 45+51 (Rodenburg et al., 2010a; Rodenburg et al., 2012). This explains the abundance of 44+47+65 and 45+51 even in the absence of PCB 68. Fifth, 44+47+65 and 45+51 have been shown to be dechlorination products in systems where only Aroclor PCBs were present (Bedard and May, 1996; Bedard et al., 1997). Sixth, there is no indication of non-commercial PCBs in the outfalls at sufficient concentrations to serve as substrates for dechlorination that might produce PCBs 4, 19, 44+47+65 and 45+51. Seventh, structurally, PCB 68 cannot be a parent PCB that produces PCBs 4, 19, 44+47+65 and 45+51. PCB 68 has four chlorines, so removal of chlorines cannot produce 44+47+65 and 45+51 which also have four chlorines. PCBs 4 and 19 have 2 and 3 chlorines in the ortho positions respectively, while PCB 68 has only one.

PCB 11 comprises about 1.6% of total PCBs in the Kaiser outfall samples, and PCB 209 comprises about 0.4% (non-detects set to zero).

MLR results

The results of the MLR analysis are presented in table 3. The MLR was sometimes re-run with PCB 11 excluded. In those cases, the Aroclors listed are those found to be significant in the regression with PCB 11 excluded. The number of peaks included in the MLR and the number of peaks detected refer to the data set when PCB 11 was included. Samples analyzed on either an SGE-HT8 or DB5 column were regressed against the Aroclor patterns as measured by Pacific Rim Laboratories. Samples analyzed on an SPB-octyl column were regressed against the Aroclors as measured by Rushneck et al. (2004). All data from the Baron and Budd v 20 database were blank corrected before being entered into the database. All data from SRRTTF was blank corrected by SRRTTF.

Table 3. Results of the MLR analysis of individual samples

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
CSO	BRWA0004	STMWTR_ERIECSO	7184223	DB5	101	87	0.85	0.85	1260				0.6%	0.1%	BB v 20
CSO	BRWA0004	STMWTR_ERIECSO	7234723	DB5	101	84	0.82	0.82	1260				0.5%	0.1%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	L2019899-2	SPB-octyl	120	108	0.71	0.85	1248	1254	1260		4.4%	0.20%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	L2046716-5	SPB-octyl	120	94	0.43	0.67	1254	1260			3.4%	0.12%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	L2046716-6	SPB-octyl	120	104	0.31	0.86	1242	1254	1260		4.7%	0.11%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	L2079391-4	SPB-octyl	120	86	0.76	0.76	1254	1260			0%	0.11%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	L2132392-2	SPB-octyl	120	86	0.78	0.89	1016	1248	1254	1260	3.5%	0.08%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	L2195827-2	SPB-octyl	120	97	0.62	0.71	1254	1260			3.6%	0.06%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	L2217966-3	SPB-octyl	120	69	0.80	0.84	1248	1254	1260		3.3%	0.11%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	PR161618	SGE-HT8	75	32	0.40	0.70	1248	1254	1260		14%	0.63%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	PR162811	SGE-HT8	75	57	0.48	0.87	1242	1248	1254	1260	10%	0%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	PR163344	SGE-HT8	75	23	0.38	0.69	1248	1254	1260		14%	0%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	PR163344D	SGE-HT8	75	33	0.55	0.76	1248	1254			12%	0%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	PR170819	SGE-HT8	75	44	0.59	0.77	1254	1260			10%	0.81%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	PR171292	SGE-HT8	75	46	0.23	0.28	1254	1260			8%	0.78%	BB v 20
Treated effluent	CityOfSpokaneWW	Spokane City WWTP	PR172157	SGE-HT8	75	17	0.15	0.15	1254				0%	0%	BB v 20
Biofilm	Biofilm	Barker Bridge (RM 90.4)	BB (1809040-03)	SPB-octyl	152	75	0.91	0.91	1242	1254	1260		0%	1.80%	SRRTTF
Tissue	Biofilm	GE Mission Left Bank caddis fly larvea	GEM-INVERT (1809040-29)	SPB-octyl	152	121	0.51	0.51	1242	1254	1260		0%	0.02%	SRRTTF
Biofilm	Biofilm	GE Mission Left Bank (RM 78.7)	GEM-LB (1809040-07)	SPB-octyl	152	123	0.90	0.92	1242	1254	1260		2.5%	0.11%	SRRTTF

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
Biofilm	Biofilm	GE Mission Right Bank (RM 78.7)	GEM-RB (1809040-08)	SPB-octyl	152	120	0.55	0.82	1242	1248	1254	1260	8.6%	0.18%	SRRTTF
Biofilm	Biofilm	Green Street Left Bank (RM 78.0)	GR-LB (1809040-09)	SPB-octyl	152	119	0.79	0.94	1242	1248	1254	1260	6.2%	0.20%	SRRTTF
Biofilm	Biofilm	Green Street Right Bank (RM 78.0)	GR-RB (1809040-10)	SPB-octyl	152	121	0.76	0.89	1242	1248	1254	1260	6.2%	0.18%	SRRTTF
Biofilm	Biofilm	Gonzaga (RM 75.0)	GZ-BF (1809040-13)	SPB-octyl	152	129	0.90	0.93	1242	1254	1260		3.1%	0.75%	SRRTTF
Biofilm	Biofilm	Gonzaga (RM 75.0)	GZ-BF-DUP (1809040-21)	SPB-octyl	152	135	0.80	0.80	1242	1248	1254	1260	1.3%	0.06%	SRRTTF
River sediment	Biofilm	Gonzaga-Sediment (RM 75.0)	GZ-SED (1809040-23)	SPB-octyl	152	138	0.99	0.99	1242	1254	1260		0.05%	0.05%	SRRTTF
River sediment	Biofilm	Gonzaga-Sediment (RM 75.0)	GZ-SED-DUP (1809040-25)	SPB-octyl	152	136	0.98	0.98	1242	1254	1260		0.08%	0.07%	SRRTTF
Biofilm	Biofilm	Harvard Bridge (RM 92.7)	HB (1809040-02)	SPB-octyl	152	98	0.85	0.85	1242	1254	1260		0%	1.08%	SRRTTF
Biofilm	Biofilm	Hangman Creek (RM 0.8)	HM-BF (1809040-16)	SPB-octyl	152	112	0.94	0.94	1242	1248	1254	1260	0%	0.32%	SRRTTF
River sediment	Biofilm	Hangman Creek (RM 0.8)	HM-SED (1809040-22)	SPB-octyl	152	120	0.94	0.95	1242	1254	1260		0.75%	1.31%	SRRTTF
Biofilm	Biofilm	Mirabeau (RM 86.6)	MBU (1809040-04)	SPB-octyl	152	108	0.62	0.66	1248	1260			3.8%	1.56%	SRRTTF
Biofilm	Biofilm	Mission Bridge (RM 76.6)	MIB (1809040-11)	SPB-octyl	152	139	0.86	0.91	1242	1248	1254	1260	2.4%	0.25%	SRRTTF
Biofilm	Biofilm	Monroe Bridge (RM 73.8)	MOB (1809040-14)	SPB-octyl	152	118	0.90	0.94	1242	1254	1260		3.8%	0.29%	SRRTTF
Biofilm	Biofilm	Nine Mile Dam (RM 57.7)	NMD (1809040-19)	SPB-octyl	152	112	0.78	0.94	1242	1248	1254	1260	7.0%	0.32%	SRRTTF
Biofilm	Biofilm	Plantes Ferry-Biofilm (RM 84.8)	PF-BF (1809040-05)	SPB-octyl	152	117	0.92	0.92	1242	1248	1254	1260	0%	0.14%	SRRTTF
River sediment	Biofilm	Plantes Ferry-Sediment (RM 83.4)	PF-SED (1809040-24)	SPB-octyl	152	131	0.78	0.78	1242	1248	1254	1260	0.07%	0.23%	SRRTTF
Biofilm	Biofilm	Spokane Gage (RM 72.7)	SG (1809040-15)	SPB-octyl	152	125	0.97	0.98	1016	1248	1254		1.9%	0.16%	SRRTTF
Tissue	Biofilm	Spokane Gage (RM 72.7)	SG-INVERT (1809040-28)	SPB-octyl	152	140	0.88	0.88	1242	1254	1260		0.23%	0.03%	SRRTTF
Tissue	Biofilm	Spokane Gage (RM 72.7)	SG-INVERT-DUP (1809040-30)	SPB-octyl	152	137	0.88	0.88	1242	1254	1260		0.24%	0.03%	SRRTTF

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
Biofilm	Biofilm	Stateline (RM 95.9)	SL (1809040-01)	SPB-octyl	152	83	0.90	0.90	1242	1254	1260		0%	1.84%	SRRTTF
Biofilm	Biofilm	Seven Mile Bridge (RM 62.0)	SMB (1809040-18)	SPB-octyl	152	112	0.50	0.93	1242	1248	1254	1260	13%	0.63%	SRRTTF
Biofilm	Biofilm	SR3A (RM 75.9)	SR3A (1809040-12)	SPB-octyl	152	136	0.87	0.87	1248	1260			0.06%	0.02%	SRRTTF
Biofilm	Biofilm	TJ Meenach (RM 69.9)	TJM (1809040-17)	SPB-octyl	152	97	0.79	0.88	1242	1254	1260		5.4%	0.93%	SRRTTF
Biofilm	Biofilm	Upriver Dam (RM 79.8)	URD (1809040-06)	SPB-octyl	152	122	0.39	0.82	1242	1248	1254	1260	13%	0.21%	SRRTTF
Biofilm	Biofilm	Upriver Dam (RM 79.8)	URD-DUP (1809040-20)	SPB-octyl	152	120	0.35	0.79	1242	1248	1254	1260	14%	0.21%	SRRTTF
Groundwater	GE Groundwater	GE	GE_MW01_102416	SPB-octyl	128	45	0.81		1016	1248	1254	1260	0%	0%	SRRTTF
Groundwater	GE Groundwater	GE	GE_MW10_102516	SPB-octyl	128	84	0.70		1016	1248	1254	1260	0%	0.26%	SRRTTF
Groundwater	GE Groundwater	GE	GE_MW11_102516	SPB-octyl	128	110	0.99		1260				0%	0.003%	SRRTTF
Groundwater	GE Groundwater	GE	GE_MW18_102416	SPB-octyl	128	89	0.93		1260				0%	0%	SRRTTF
Groundwater	GE Groundwater	GE	GE_MW19_102516	SPB-octyl	128	107	0.97		1260				0%	0.01%	SRRTTF
Groundwater	GE Groundwater	GE	GE_MW20_102416	SPB-octyl	128	93	0.54		1260				0%	0.02%	SRRTTF
Groundwater	GE Groundwater	GE	GE_MW21_102516	SPB-octyl	128	106	0.91		1254	1260			0%	0.03%	SRRTTF
Groundwater	GE Groundwater	GE	GE_MW22_102516	SPB-octyl	128	89	0.63		1260				0%	0%	SRRTTF
Treated industrial wastewater	IEP 2005-2017	IEP	2nd Effluent	SPB-octyl	120	83	0.78	0.94	1016	1248			8.3%	0.05%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	42366	SPB-octyl	120	68	0.53	0.89	1016				15%	0.05%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	42380	SPB-octyl	120	66	0.48	0.90	1016				17%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Effluent	SPB-octyl	120	94	0.57	0.94	1016	1248	1254	1260	11%	0.05%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Effluent 1	SPB-octyl	120	108	0.87	0.91	1016	1248			4.1%	0.02%	BB v20
Treated industrial wastewater	EffluentE2_2015_2016	IEP	L24531-2	SPB-octyl	120	66	0.48	0.90	1016				17%	0%	BB v20

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
Treated industrial wastewater	EffluentE2_2015_2016	IEP	L24531-1	SPB-octyl	120	68	0.53	0.89	1016				15%	0.05%	BB v20
Treated industrial wastewater	SGOL005	IEP	1188181	SPB-octyl	120	70	0.47	0.98	1016	1248	1254	1260	16%	0%	BB v20
Treated industrial wastewater	SRRTTF-2015	IEP	L24358-2	SPB-octyl	120	111	0.81	0.83	1016	1248			3.3%	0.03%	BB v20
Treated industrial wastewater	SRRTTF-2018	IEP	L29830-3	SGE-HT8	110	100	0.53	0.77	1016				12%	0.03%	BB v20
Treated industrial wastewater	SRRTTF-2018	IEP	L29834-12 i	SGE-HT8	110	99	0.66	0.80	1016				8.7%	0.04%	BB v20
Treated industrial wastewater	SRRTTF-2018	IEP	L29850-5	SGE-HT8	110	87	0.72	0.85	1016				8.0%	0.04%	BB v20
Treated industrial wastewater	SRRTTF-2018	IEP	L29884-8	SGE-HT8	110	95	0.69	0.82	1016				8.1%	0.02%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent	SPB-octyl	154	83	0.78		1016	1248			9.1%	0.04%	BB v20
Treated industrial wastewater	SRRTTF-2014	IEP	L21917-6 W	SPB-octyl	154	129	0.87		1016	1248			5.3%	0.02%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Site 3 Week 1	SPB-octyl	154	88	0.79		1016	1248			7.0%	0%	BB v20
Treated industrial wastewater	SRRTTF-2014	IEP	L21877-90	SPB-octyl	154	104	0.85		1016				5.2%	0.01%	BB v20
Treated industrial wastewater	SRRTTF-2014	IEP	L21910-11	SPB-octyl	154	116	0.87		1016				5.0%	0.03%	BB v20
Treated industrial wastewater	SRRTTF-2014	IEP	L21917-5 W	SPB-octyl	154	145	0.87		1016	1248			5.2%	0.04%	BB v20
Treated industrial wastewater	SRRTTF-2015	IEP	L23783-24	SPB-octyl	154	121	0.90		1016	1248			4.0%	0.02%	BB v20

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
Treated industrial wastewater	SRRTTF-2015	IEP	L23783-42	SPB-octyl	154	109	0.86		1016	1248			5.3%	0.01%	BB v20
Treated industrial wastewater	SRRTTF-2015	IEP	L23784-38	SPB-octyl	154	114	0.87		1016	1248			4.8%	0%	BB v20
Treated industrial wastewater	SRRTTF-2014	IEP	L21874-7	SPB-octyl	154	114	0.85		1016	1248			4.9%	0.01%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	FilEff12/18/11	DB5	122	55	0.19	0.81	1016	1254			24%	0.07%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	IEP Fil Eff 5-13-14	DB5	122	58	0.72	0.94	1016				11%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	IEP Fil Eff 8-27-14	DB5	122	85	0.87	0.92	1016	1248			4.5%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	IEP Fil EffPCB	DB5	122	67	0.52	0.83	1016	1254			13%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent	DB5	122	40	0.42	0.84	1016	1254			18%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent.1	DB5	122	23	0.21	0.83	1016	1254			30%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent.2	DB5	122	46	0.18	0.87	1016	1254			28%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent.3	DB5	122	36	0.54	0.75	1016				13%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent.4	DB5	122	42	0.46	0.83	1016	1248	1254		15%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent.5	DB5	122	44	0.83	0.90	1016				6.4%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent.6	DB5	122	115	0.35	0.80	1016	1254			17%	0.05%	BB v20

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent.7	DB5	122	92	0.75	0.92	1016	1248			8.6%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent.8	DB5	122	110	0.91	0.92	1016	1248			1.8%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Fil Effluent.9	DB5	122	54	0.72	0.92	1016				11%	0%	BB v20
Treated industrial wastewater	IEP NPDES Testing	IEP	1400356-01	DB5	122	58	0.72	0.94	1016				11%	0%	BB v20
Treated industrial wastewater	IEP NPDES Testing	IEP	1400637-01	DB5	122	85	0.87	0.92	1016	1248			4.5%	0%	BB v20
Treated industrial wastewater	IEP 2005-2017	IEP	Secondary Clarifier Effluent	DB5	122	22	NS	0.79	1016	1248			42%	0%	BB v20
Atmospheric deposition	BERA0013	Augusta_AIR	1705077-5	SPB-octyl	148	66	0.69	0.68	1254	1260			0%	0%	SRRTTF
Atmospheric deposition	BERA0013	Augusta_AIR	1608070-5	SPB-octyl	148	110	0.12	0.90	1242	1248	1254	1260	15%	0.14%	SRRTTF
Atmospheric deposition	BERA0013	Augusta_AIR	1611056-4	SPB-octyl	148	115	0.90	0.90	1242	1254	1260		1.4%	0.11%	SRRTTF
Atmospheric deposition	BERA0013	Augusta_AIR	1611056-5	SPB-octyl	148	102	0.89	0.91	1242	1254	1260		1.9%	0.15%	SRRTTF
Atmospheric deposition	BERA0013	Augusta_AIR	1611056-5.1	SPB-octyl	148	102	0.89	0.91	1242	1254	1260		2.2%	0.09%	SRRTTF
Atmospheric deposition	BERA0013	Augusta_AIR	1709040-2	SPB-octyl	148	147	0.63	0.86	1016	1254			9.8%	0.01%	SRRTTF
Atmospheric deposition	BERA0013	Augusta_AIR	1709040-3	SPB-octyl	148	143	0.67	0.89	1016	1248	1254		9.4%	0.01%	SRRTTF
Atmospheric deposition	BERA0013	Augusta_AIR	1709040-4	SPB-octyl	148	142	0.62	0.81	1016	1248	1254		8.5%	0.01%	SRRTTF
Atmospheric deposition	BERA0013	Augusta_AIR	1702021-1	SPB-octyl	148	97	0.74	0.89	1242	1254	1260		6.4%	0.13%	SRRTTF
Atmospheric deposition	BERA0013	Monroe_AIR	1705077-2	SPB-octyl	148	44	0.11	0.21	1242	1254			21%	0%	SRRTTF
Atmospheric deposition	BERA0013	Monroe_AIR	1608070-2	SPB-octyl	148	101	NS	0.59	1242	1254			26%	0.13%	SRRTTF
Atmospheric deposition	BERA0013	Monroe_AIR	1608070-3	SPB-octyl	148	97	0.40	0.45	1242	1254	1260		6.3%	0.19%	SRRTTF

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
Atmospheric deposition	BERA0013	Monroe_AIR	1608070-3.1	SPB-octyl	148	100	0.40	0.44	1242	1254	1260		6.1%	0.19%	SRRTTF
Atmospheric deposition	BERA0013	Monroe_AIR	1611056-2	SPB-octyl	148	68	0.30	0.33	1242	1254			6.6%	0%	SRRTTF
Atmospheric deposition	BERA0013	Monroe_AIR	1702021-2	SPB-octyl	148	96	0.57	0.74	1242	1254	1260		7.8%	0.12%	SRRTTF
Atmospheric deposition	BERA0013	Turnbull	1705077-4	SPB-octyl	148	2	NS	NS					0%	0%	SRRTTF
Atmospheric deposition	BERA0013	Turnbull	1705077-4.1	SPB-octyl	148	1	NS	NS					0%	0%	SRRTTF
Atmospheric deposition	BERA0013	Turnbull	1608070-4	SPB-octyl	148	50	0.17	0.25	1242	1254			17%	0.21%	SRRTTF
Atmospheric deposition	BERA0013	Turnbull	1611056-3	SPB-octyl	148	32	0.14	0.16	1242	1254			12%	0%	SRRTTF
Atmospheric deposition	BERA0013	Turnbull	1702021-3	SPB-octyl	148	88	NS	0.72	1242	1254	1260		27%	0.53%	SRRTTF
Atmospheric deposition	BERA0013	Turnbull	1702021-5	SPB-octyl	148	69	NS	0.78	1242	1254	1260		46%	0.12%	SRRTTF
Storm drain solids	SRUWSpokane	Stormwater manhole Hogan and Front	1207107-02	SPB-octyl	149	141	0.89		1242	1254	1260		0.25%	0.11%	SRRTTF
Storm drain solids	SRUWSpokane	Pacific Steel and Recycling swale	1206085-01	SPB-octyl	149	144	0.96		1016	1248	1254	1260	0.05%	0.03%	SRRTTF
River sediment	SRUWSpokane	Spokane River near Avista	1308073-12	SGE-HT8	177	110	0.82		1242	1254	1260		0.25%	0.25%	SRRTTF
Storm drain solids	SRUWSpokane	Curb Sample on Trent	1210073-03	SGE-HT8	177	147	0.96		1248	1254	1260		0.11%	0.11%	SRRTTF
Storm drain solids	SRUWSpokane	Fiske and Trent 1379308IN	1211041-01	SGE-HT8	177	147	0.87		1254	1260			0.40%	0.09%	SRRTTF
River sediment	SRUWSpokane	Spokane River near Iron Bridge	1308073-03	SGE-HT8	177	125	0.78		1242	1248	1254	1260	0.60%	0.20%	SRRTTF
River sediment	SRUWSpokane	Spokane River near Iron Bridge	1308073-03REX	SGE-HT8	177	89	0.86		1242	1248	1254	1260	0.53%	0.09%	SRRTTF
Storm drain solids	SRUWSpokane	Island Curb at Regal and Trent	1210073-02	SGE-HT8	177	148	0.96		1248	1260			0.33%	0.06%	SRRTTF
River sediment	SRUWSpokane	Spokane River near Hamilton	1308073-13	SGE-HT8	177	136	0.88		1242	1248	1254	1260	0.15%	0.10%	SRRTTF
Storm drain solids	SRUWSpokane	Regal East Curb	1210073-01	SGE-HT8	177	151	0.96		1248	1260			0.53%	0.11%	SRRTTF
River sediment	SRUWSpokane	Spokane River near Stone St	1308073-05	SGE-HT8	177	141	0.72		1242	1248	1260		0.31%	0.31%	SRRTTF

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
River sediment	SRUWSpokane	Spokane River near Centennial Trail	1308073-04	SGE-HT8	177	142	0.76		1242	1248	1254	1260	0.24%	0.14%	SRRTTF
River sediment	SRUWSpokane	Spokane River dwnstrm of Upriver Dam	1308073-02	SGE-HT8	177	108	0.70		1242	1248	1260		0.94%	0.06%	SRRTTF
River sediment	SRUWSpokane	Spokane River downstream of Upriver Dam	1308073-01	SGE-HT8	177	108	0.65		1242	1248	1254	1260	1.4%	0.11%	SRRTTF
River sediment	SRUWSpokane	Spokane River downstream of Upriver Dam	1308073-01REX	SGE-HT8	177	71	0.77		1242	1248	1254	1260	1.8%	0.35%	SRRTTF
River sediment	SRUWSpokane	Spokane River downstream of Upriver Dam	1308073-06	SGE-HT8	177	111	0.67		1242	1248	1260		0.87%	0.07%	SRRTTF
River sediment	SRUWSpokane	Spokane River downstream of Upriver Dam	1308073-06REX	SGE-HT8	177	76	0.90		1242	1248	1254		1.0%	0.002%	SRRTTF
River sediment	SRUWSpokane	Spokane River dwnstrm S of Upriver Dam	1308073-10	SGE-HT8	177	74	0.73		1242	1248	1260		1.5%	0%	SRRTTF
Stormwater	CityOfSpokaneWW	Cochran Basin	L2019899-5	SPB-octyl	149	115	0.89	0.93	1248	1254	1260		3.3%	0.38%	BB v20
Stormwater	CityOfSpokaneWW	Cochran Basin	L2021980-3	SPB-octyl	149	146	0.93	0.94	1016	1248	1254	1260	1.6%	0.32%	BB v20
Stormwater	CityOfSpokaneWW	Cochran Basin	L2073458-1	SPB-octyl	149	101	0.75	0.95	1016	1248	1254	1260	7.7%	0.52%	BB v20
Stormwater	CityOfSpokaneWW	Cochran Basin	L2073458-2	SPB-octyl	149	86	0.46	0.65	1254	1260			10%	0.60%	BB v20
Stormwater	CityOfSpokaneWW	Cochran Basin	L2193583-3	SPB-octyl	149	133	0.92	0.93	1248	1254	1260		2.2%	0.32%	BB v 20
Stormwater	CityOfSpokaneWW	Cochran Basin	L2208880-1	SPB-octyl	149	131	0.89	0.95	1016	1248	1254	1260	3.9%	0.40%	BB v20
Stormwater	CityOfSpokaneWW	Cochran Basin	L2230025-1	SPB-octyl	149	136	0.89	0.93	1016	1248	1254	1260	3.1%	0.33%	BB v20
Stormwater	CityOfSpokaneWW	Cochran Basin	L2230025-2	SPB-octyl	149	136	0.89	0.92	1016	1248	1254	1260	3.0%	0.39%	BB v20
Stormwater	SRUW-Spokane	G1-7	1211029-03	SPB-octyl	149	115	0.96	0.96	1248	1254	1260		0%	0.11%	BB v20
Stormwater	SRUW-Spokane	G1-7	1211029-04	SPB-octyl	149	127	0.91	0.91	1248	1260			0.17%	1.0%	BB v20
Stormwater	SRUW-Spokane	Hogan	1305055-01	SPB-octyl	149	122	0.97	0.97	1254	1260			1.1%	0.15%	BB v20
Stormwater	SRUW-Spokane	Hogan	1305055-02	SPB-octyl	149	110	0.95	0.95	1254	1260			1.2%	0.17%	BB v20
Stormwater	SRUW-Spokane	HoganF	1211029-02	SPB-octyl	149	105	0.81	0.81	1254	1260			0%	0.08%	BB v20

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
Stormwater	SRUW-Spokane	PacSteel	1206085-02	SPB-octyl	149	143	0.96	0.96	1016	1248	1254	1260	0.20%	0.04%	BB v 20
Stormwater	ABOR0001	Ralph	01-03142017	SPB-octyl	149	100	0.93	0.93	1248	1254	1260		0%	0.61%	BB v 20
Stormwater	ABOR0001	Ralph	01-03142017.1	SPB-octyl	149	105	0.93	0.93	1248	1254	1260		0%	0.61%	BB v 20
Stormwater	SRUW-Spokane	Spg-Alta	1211047-01	SPB-octyl	149	137	0.96	0.96	1254	1260			1.2%	0.11%	BB v 20
Stormwater	DSER0010	STMMISSBR	4254001	SPB-octyl	149	56	0.93	0.93	1254	1260			0%	0.41%	BB v 20
Stormwater	DSER0010	STMSUPOUT	4254003	SPB-octyl	149	22	0.90	0.90	1248	1254	1260		0%	0%	BB v 20
Stormwater	DSER0010	STMWASHBR	4254002	SPB-octyl	149	46	0.94	0.94	1248	1254	1260		0%	0%	BB v 20
Stormwater	SRUW-Spokane	Trent G1-6a	1203081-02	SPB-octyl	149	130	0.96	0.96	1248	1260			0.60%	0.07%	BB v 20
Stormwater	SRUW-Spokane	Trent G1-6b	1203081-05	SPB-octyl	149	131	0.97	0.97	1248	1254	1260		0.28%	0.08%	BB v 20
Stormwater	SRUW-Spokane	Trent@Hogan	1304046-01	SPB-octyl	149	132	0.95	0.96	1248	1254	1260		1.5%	0.18%	BB v 20
River sediment	WHOB003	Union Gospel Mission Dock	1702027-26	SPB-octyl	149	133	0.95		1242	1248	1254	1260	0.86%	0.37%	SRRTTF
River sediment	WHOB003	Union Gospel Mission Dock	1702027-27	SPB-octyl	149	135	0.85		1242	1248	1254	1260	0.75%	0.43%	SRRTTF
River sediment	WHOB003	Union Gospel Mission Dock	1606035-20	SPB-octyl	149	137	0.96		1242	1248	1254	1260	0%	0.31%	SRRTTF
River sediment	WHOB003	Union Gospel Mission Dock	1606035-21	SPB-octyl	149	135	0.96		1242	1248	1254	1260	0%	0.28%	SRRTTF
River sediment	DSER0010	BUFFALO REF	3458103-S	SPB-octyl	101	24	0.64		1254	1260			0%	5.5%	SRRTTF
River sediment	DSER0010	Harvard	3438100	SPB-octyl	101	34	0.82		1254	1260			0%	0%	SRRTTF
River sediment	DSER0010	LitlSpokSed	3504060	SPB-octyl	101	19	0.23		1260				0%	0%	SRRTTF
River sediment	DSER0010	Littlefls	3454113	SPB-octyl	101	21	0.48		1254	1260			0%	0%	SRRTTF
River sediment	DSER0010	LongLkLow	3454112	SPB-octyl	101	77	0.85		1242	1248	1254	1260	0%	0.29%	SRRTTF
River sediment	DSER0010	LongLkLow	3454114	SPB-octyl	101	74	0.83		1242	1248	1254	1260	0%	0.28%	SRRTTF
River sediment	DSER0010	LongLkMid	3454111	SPB-octyl	101	74	0.85		1242	1248	1254	1260	0%	0.32%	SRRTTF
River sediment	DSER0010	LongLkUp	4208147	SPB-octyl	101	98	0.89		1242	1248	1254	1260	0%	0.24%	SRRTTF
River sediment	DSER0010	MonroeSed	4168149	SPB-octyl	101	59	0.82		1254	1260			0%	0%	SRRTTF

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
River sediment	DSER0010	NINEM SPM	3454105	SPB-octyl	101	82	0.93		1242	1254	1260		0%	0.22%	SRRTTF
River sediment	DSER0010	PLANTEFRY	3448100	SPB-octyl	101	40	0.72		1254	1260			0%	0%	SRRTTF
River sediment	DSER0010	SPOK-1	3458100-S	SPB-octyl	101	53	0.74		1242	1248	1254	1260	0%	0%	SRRTTF
River sediment	BERA0009	9MD-SEDT	1304017-01	SGE-HT8	174	109	0.89		1242	1248	1254	1260	0.97%	0.37%	SRRTTF
River sediment	BERA0009	9MD-SEDT	1304017-04	SGE-HT8	174	105	0.87		1242	1248	1254	1260	1.1%	0.25%	SRRTTF
River sediment	BERA0009	9MD-SEDT	1306061-01	SGE-HT8	174	99	0.85		1242	1248	1254	1260	0%	0.25%	SRRTTF
River sediment	BERA0009	UPRD-SEDT	1304017-02	SGE-HT8	174	112	0.85		1242	1248	1254	1260	0.77%	0.14%	SRRTTF
River sediment	BERA0009	UPRD-SEDT	1304017-03	SGE-HT8	174	108	0.83		1242	1248	1254	1260	1.2%	0.11%	SRRTTF
River sediment	BERA0012	LFP SedTraps	1606061-1	SPB-octyl	148	134	0.95		1242	1248	1254	1260	0.53%	0.36%	SRRTTF
River sediment	BERA0012	LFP SedTraps	1606061-2	SPB-octyl	148	139	0.94		1242	1248	1254	1260	0.98%	0.42%	SRRTTF
River sediment	BERA0012	LFP SedTraps	1606061-3	SPB-octyl	148	144	0.93		1242	1248	1254	1260	0.57%	0.28%	SRRTTF
River sediment	BERA0012	LFP SedTraps	1606061-4	SPB-octyl	148	144	0.94		1242	1248	1254	1260	0.54%	0.31%	SRRTTF
River sediment	BERA0012	LFP SedTraps	1606061-5	SPB-octyl	148	141	0.94		1242	1248	1254	1260	0.58%	0.33%	SRRTTF
River sediment	BERA0012	UGM	1602016-13	SPB-octyl	148	30	0.08		1260				0%	0%	SRRTTF
River sediment	BERA0012	UGM	1602016-14	SPB-octyl	148	29	NS						0%	0%	SRRTTF
CLAM*		Nine Mile Dam	1210040-23	SGE-HT8	126	98	0.14	0.71	1248	1254	1260		0%	0.20%	SRRTTF
CLAM*		Nine Mile Dam	1210040-24	SGE-HT8	126	98	0.27	0.78	1248	1254	1260		0%	0.27%	SRRTTF
CLAM*		Nine Mile Dam	1210040-25	SGE-HT8	126	96	0.55	0.79	1248	1254	1260		0%	0%	SRRTTF
CLAM*		Nine Mile Dam	1210040-27	SGE-HT8	126	117	0.75	0.77	1248	1254	1260		0%	0.49%	SRRTTF
CLAM*		Upriver Dam	1210040-28	SGE-HT8	126	89	0.79	0.83	1016	1248	1254		0%	0%	SRRTTF
CLAM*		Upriver Dam	1210040-29	SGE-HT8	126	86	0.79	0.81	1016	1248			0%	0%	SRRTTF
CLAM*		Upriver Dam	1210040-30	SGE-HT8	126	97	0.70	0.79	1016	1248			0%	0%	SRRTTF

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	R2	R2 w/o PCB 11	Aroclor(s)				PCB 11	PCB-209	Data source
Storm drain solids	SRUW-Spokane	HoganF	1207107-02	SPB-octyl	159	142	0.89		1242	1254	1260		0.25%	0.11%	BB v20
Storm drain solids	SRUW-Spokane	PacSteel	1206085-01	SPB-octyl	159	145	0.96		1016	1248	1254	1260	0.05%	0.03%	BB v20
Storm drain solids	DOST0001	UNIONLPT	1202023-01	SPB-octyl	159	147	0.97		1248	1254	1260		0.80%	0.12%	BB v20
Storm drain solids	DOST0001	UNIONLPT	1203042-01	SPB-octyl	159	147	0.96		1248	1254	1260		0.85%	0.14%	BB v20
Storm drain solids	SRUW-Spokane	Curb Davis	1210073-03	SGE-HT8	151	145	0.96		1248	1254	1260		0.11%	0.11%	BB v20
Storm drain solids	SRUW-Spokane	Fiske Trent	1211041-01	SGE-HT8	151	145	0.87		1254	1260			0.40%	0.09%	BB v20
Storm drain solids	SRUW-Spokane	Island West	1210073-02	SGE-HT8	151	146	0.96		1248	1260			0.33%	0.06%	BB v20
Storm drain solids	SRUW-Spokane	Regal East	1210073-01	SGE-HT8	151	149	0.96		1248	1260			0.53%	0.11%	BB v20

NS = not significant

* = "R2 w/o PCB 11" for these samples is the R2 when PCB 7 is excluded. PCB 11 was not detected in these samples.

CSOs

As noted above, most of the City of Spokane CSO samples were analyzed using PMF and the results are described in the section on PMF. Two samples were measured using a different (DB5) GC column from studyID BRWA0004, so these two were analyzed via MLR. PCBs in these two samples arise almost exclusively from Aroclors. These two samples were strongly similar to Aroclor 1260. PCBs 11 and 209 were much less than 1% of the sum of PCBs in these samples.

Stormwater

As described above, most of the City of Spokane stormwater samples were examined using PMF. Twenty-three samples were excluded from the PMF analysis because they were analyzed on an SPB-octyl column. These samples were from studyIDs CityOfSpokaneWW (8 samples), SRUW-Spokane (10), ABOR0001 (2), and DSER0010 (3). The MLR results for these samples suggest that more than 95% of PCBs in these samples arise from Aroclors. Only one sample gives an R2 values less than 0.75 when PCB 11 is included in the correlation. The R2 for this sample (L2073458-2 from the Cochran Basin) is 0.46 and increases to 0.65 when PCB 11 is excluded from the correlation. This sample contains the most PCB 11 (10%) among the 23 samples. In the remaining samples, PCB 11 ranged from non-detect to 7.7% and averaged 1.8%.

Storm drain solids

More than 95% of PCBs in storm drain solids collected in the study area come from Aroclors. Eight samples of storm drain solids were collected under two studies (SRUW-Spokane, and DOST0001) (Lubliner, 2012). The MLR results indicate that all eight samples strongly resemble Aroclors, with R2 values ranging from 0.87 to 0.97. PCB 11 is less than 1% of the sum of PCBs in most samples. PCB 209 is less than 1% of the sum of PCBs in all eight samples.

City of Spokane Treated Effluent

Aroclors account for more than 90% of PCBs in the treated effluent of the Spokane City WWTP. When PCB 11 is excluded from the correlation, these samples (from studyID CityOfSpokaneWW) generally show strong similarity with mixtures of Aroclors. In samples where the R2 value of the MLR is low, very few congeners were detected. For example, in sample ID PR172157, the R2 value is just 0.15 because only 17 congeners were detected in this sample. This does not indicate non-commercial PCB sources, since PCBs 11 and 209 were not detected in this sample. The contribution of PCB 11 to these samples ranged from non-detect to 14% of the sum of PCBs. The average contribution of PCB 11 is 6.5%. PCB 209 is less than 1% of PCBs in all of these samples.

Bulk atmospheric deposition

Aroclors are the dominant sources of PCBs in the bulk atmospheric deposition samples. PCB 11 ranged from non-detect to 46% of the PCBs in the atmospheric deposition samples. The mass-weighted average of PCB 11 across the bulk deposition samples is 8.5%. As is common across these data sets, the R2 value for the MLR increases as more congeners are detected. This is

symptomatic of the difficulty of conducting fingerprinting in data sets with low concentrations that lead to large numbers of non-detect values. In this case, it also seems indicative of blank contamination that is most problematic for samples with low concentrations/fluxes. Once the flux rises above 2 ng/m^2/d, the R2 for the MLR is always above 0.74.

The congeners that were most abundant in the *blanks* for this study were (in order of abundance) PCBs 11, 8, 20/28, 4, 1, 31, 44/47/65, 3, 9, 18/30, 15, 21/33, and 2. All of these congeners were detected in silicone products by Anezaki and Nakano (2015). These congeners are also abundant in the samples with the lowest fluxes even after blank correction. This may indicate that the blank correction procedure for this study was inadequate. Contamination by silicone products was thought to be a problem in the atmospheric deposition study in the Green-Duwamish River, which used similar methods (Rodenburg et al., 2019).

Biofilm

Aroclors account for more than 90% of PCBs in the biofilm samples. The biofilm samples were collected in order to characterize the surface water dissolved-phase PCB concentrations, since biofilm acts as a passive sampler of the water column (Wong and Era-Miller, 2019). Therefore the predominance of Aroclor PCBs in the biofilm suggests that Aroclor PCBs also dominated in the water column. Non-commercial PCBs were found in biofilm samples. PCB 11 ranged from non-detect to 14% of the sum of PCBs, and averaged 4.4%. This is in reasonable agreement with the approximately 10% of the surface water PCBs that were found to be associated with non-commercial PCBs in the surface water PMF results above. PCB 209 was less than 2% of the sum of PCBs in all biofilm samples.

The biofilm study also collected three samples of organism tissue (caddis and mayfly larvae) (Wong and Era-Miller, 2019). PCB congener profiles in two of these samples were very similar to the Aroclors (R2 = 0.88). The third sample yielded a lower R2 value of 0.51 but this was not due to the presence of PCB 11 (which was not detected in this sample) or other non-commercial PCBs. Instead, the low R2 may be due to metabolism of PCBs. In all other biofilm samples, the ratio of 147+149/153+168 (used as an indicator of metabolism) ranged from 0.61 to 1.18, but in sample GEM-INVERT (1809040-29) the ratio was just 0.20.

The biofilm project also collected four samples of river sediment. These are discussed in the section on river sediment below.

River sediment

More than 95% of PCBs in river sediment samples arise from Aroclors. Samples of river sediment were collected in several studies:

- The biofilm study analyzed four samples of river sediment using a SPB-octyl column.
- SRUWSpokane analyzed thirteen samples of river sediment using an SGE-HT8 column.
- WHOB003 analyzed four samples of river sediment using an SPB-octyl column.
- DSER0010 analyzed twelve samples of river sediment using an SPB-octyl column.
- BERA0009 analyzed five samples of river sediment using an SPB-octyl column.

- BERA0012 analyzed seven samples of river sediment using an SPB-octyl column.

Whenever more than 30 peaks were detected, congener patterns in these sediment samples resembled Aroclors with R2 values greater than 0.72. PCB 11 was never more than 1.2% of the sum of PCBs in these samples, and PCB 209 was usually much less than 1%, although it was 5.5% of the sum of PCBs in sample 3458103-S. This sample had only 24 peaks detected.

GE groundwater

Eight samples of groundwater from the GE site indicate that Aroclors are the sole source of PCBs to these samples, with Aroclor 1260 predominant. PCB 11 was not detected in these samples, and PCB 209 was always less than 0.5% of the sum of PCBs. The presence of PCB 209 can be explained by Aroclor 1260 since this formulation contains some PCB 209 (Rushneck et al., 2004). Samples GE_MW01_102416 and GE_MW10_102516 had relatively high proportions of PCBs 44+47+65 (10% and 5% of the sum of PCBs respectively). Given the near absence of PCB 68 in these samples, the presence of PCBs 44+47+65 probably indicates that microbial dechlorination of PCBs is occurring to a limited extent in the groundwater at the GE site.

Inland Empire Paper (EIP)

Forty samples from the EIP facility, most of which represent treated effluent, indicate that the main source of PCBs to their facility is Aroclors, particularly Aroclor 1016 (with 1242 being very similar in fingerprint and probably present). This is to be expected given that Aroclor 1242 was used in carbonless copy paper (Agency for Toxic Substances and Disease Registry (ATSDR), 2000). PCB 11 is often present in high proportions in the IEP facility, ranging from 1.8% to 42% of the sum of PCBs. The highest proportion of PCB 11 was found in a sample from their secondary clarifier, i.e. water that had not undergone the full treatment process. The average contribution of PCB 11 was 11% across all samples analyzed by MLR. Again, high contributions from PCB 11 were expected since PCB 11 is found in inks used in paper (Rodenburg et al., 2010b). MLR was not performed on three samples of effluent from the IEP site from study DSER0010. In two of these samples, no PCBs were detected. In the third sample, only three congeners were detected: PCBs 1, 2, and 11.

Surface water CLAM samples

The CLAM (Continuous low-level aquatic monitoring) sampling system was used to collect seven samples representing surface water at Nine Mile Dam and Upriver Dam. MLR conducted on these samples suggests that Aroclors are the main source of PCBs in the surface water. Three of the four samples from Nine Mile Dam had high contributions of PCB 7 ranging from 5% to 20% of the sum of PCBs. In all other CLAM samples, PCB 7 was less than 4% of the sum of PCBs. PCB 7 comprised 9.4% of the mass-weighted average total PCBs. I have never before in my professional experience encountered such high proportions of PCB 7. When this congener is included in the MLR, the R2 values for these three samples are relatively low, ranging from 0.14 to 0.55. When this congener is excluded, the R2 values for all of the CLAM samples range from 0.71 to 0.83, suggesting that Aroclors are the dominant source of PCBs in these samples. These

are the R2 values shown in table 3 under "R2 w/o PCB 11". PCB 11 was not detected in any of these samples. PCB 209 was detected in three of the seven samples and comprised 0.2% of the mass-weighted average sum of PCBs.

Municipal products study

The City of Spokane conducted a study in which PCBs were measured in a variety of consumer products (City of Spokane Wastewater Management Department, 2015). My analysis of this data (Table 4) indicates that the PCBs detected in many of these products probably arose from Aroclors. It is therefore not appropriate to assume that all PCBs in consumer products arise from non-commercial (i.e., non-Aroclor) sources.

The highest R2 values for the MLR were found for short liner (used to repair pipes without having to replace them) (R2 = 0.86), crack sealer (0.86), lignosulfonate dust suppressant (0.75), road salt (0.68 and 0.64), sand for road traction (0.65), and CIPP (cured in place piping) (0.64). Several other products returned R2 values above 0.4, including hydroseed, salt brine solution, hydrostraw (undyed), deicer, antifreeze, yellow road tape, synthetic motor oil, class B Fire Fighting Foam, and calcium chloride deicer. These products may have passively absorbed Aroclor PCBs from the atmosphere, could be the result of recycled PCB-containing equipment, or been exposed to Aroclor PCBs via contact with contaminated equipment, oil, etc. The U. S. Environmental Protection Agency (2018) states that "The mismanagement of used oil contaminated with PCBs is a recurring issue faced by EPA and states, commercial and municipal used oil collection centers, and recyclers. Used oil transporters pick up oil from a variety of facilities, often without knowing the PCB concentration." Some fractions of used oil can be used in the making of asphalt (Arnold, 2017) which may explain the presence of Aroclors in the crack sealer.

My results are in agreement with those of the authors of the consumer products study, who noted the similarity of congener patterns between Aroclors and products such as thermoplastic tape, lignosulfonate, crack sealer, hydroseed, and short liner. The authors noted that the crack sealer congener pattern was most similar to Aroclor 1242, and that "Aroclor 1242 had a wide variety of end uses, one of them being in rubbers. One of the ingredients in the crack sealer is vulcanized rubber compound" (City of Spokane Wastewater Management Department, 2015).

Table 4. Results of MLR analysis of municipal products measured in consumer products by the City of Spokane (City of Spokane Wastewater Management Department, 2015).

Product	**Sample ID**	**R2**	**Aroclor(s)**	**PCB 11**	**PCB 209**
Short Liner	031-100314-1330	0.86	1242 1254	1.0%	0%
Crack Sealer	026-100214-1450	0.86	1242 1254	4.1%	0%
Lignosulfonate (dust sup.)	022-092914-124	0.75	1242 1254 1260	0%	0%
COS Road Salt FIELD DUP	Replicate #4	0.68	1242 1248 1254 1260	6.0%	0%

Product	Sample ID	R2	Aroclor(s)				PCB 11	PCB 209
Sand (Road Traction) LAB DUP	P312-021616-1430 DUP	0.65	1248	1260			0%	0%
Sand (Road Traction)	P312-021616-1430	0.65	1242	1248	1260		0%	0%
COS Road Salt	P304-122215-0920	0.64	1242	1248	1254	1260	6.5%	0%
CIPP	030-100314-1330	0.64	1242	1254			4.3%	0%
hydroseed	028-100214-1515	0.59	1248	1260			2.1%	0.02%
WSDOT Salt Brine Soln. FIELD DUP	Replicate #3	0.56	1242	1254			6.3%	0%
hydrostraw (undyed)	201-030915-1258	0.54	1242	1254			11%	0%
WSDOT Deicer	009-091614-1520	0.52	1242	1254	1260		5.8%	0%
Anti Freeze	035-082714-1453	0.45	1254	1260			7.8%	4.3%
yl rd tape	034-091014-1328	0.45	1242				16%	0.3%
syn. motor oil	017-082614-1400	0.44	1242	1260			15%	0%
Class B FFF	007-082814-1401	0.41	1242	1254	1260		0%	2.8%
CaCl Deicer	P302-010716-1030	0.40	1242	1254	1260		7.0%	0%
hand soap	101-101314-1100	0.40	1242	1248			0%	0%
Sand (Road Traction) FIELD DUP	Replicate #6	0.39	1242	1254			14%	0%
dish soap	103-101314-1100	0.38	1242				10%	0%
MgCl Deicer LAB DUP	P301-122215-0830 DUP	0.37	1242	1260			21%	0.9%
WSDOT NaCl salt FIELD DUP	Replicate #5	0.37	1254	1260			8.8%	0%
Hotsy Soap LAB DUP	010-090914-0906 DUP	0.35	1242	1254	1260		0%	0.9%
WSDOT Salt Brine Soln.	P303-010716-0938	0.35	1254	1260			7.1%	0%
Sand (Road Traction) LAB DUP	B6C0145-DUP1	0.34	1254				0.5%	0.3%
hydrant paint	005-100314-1430 DUP	0.33	1242	1254			0%	0%
roundup	014-091814-0945	0.33	1242				0%	0%
Sand (Road Traction) LAB DUP	Replicate #6 DUP	0.32	1242	1248			14%	0%
Sand (Road Traction)	V312-021616-1430	0.32	1254				0.6%	0.2%
WSDOT NaCl salt	V314-022316-1030	0.31	1254				0.4%	0.2%
MgCl Deicer	V309-021016-0910	0.31	1248	1254			0.7%	0.2%
Sand (Road Traction)	P306-122215-0916	0.31	1242	1260			14%	0%

Product	Sample ID	R2	Aroclor(s)	PCB 11	PCB 209
COS Road Salt	V311-021616-1435	0.31	1254	0.4%	0.4%
MgCl Deicer LAB DUP	B6C0121-DUP1	0.31	1248 1254	0.8%	0.3%
COS Road Salt LAB DUP	P311-021616-1435 DUP	0.30	1248	0%	14%
CaCl Deicer	P310-021616-1415	0.29	1248 1260	0%	0%
COS Road Salt LAB DUP	P304-122215-0920 DUP	0.28	1248 1260	19%	0%
WSDOT NaCl salt	P305-010716-0935	0.28	1248 1260	16%	0%
wt rd tape	036-091014-1329	0.24	1242 1248	21%	0%
WSDOT NaCl salt	P314-022316-1030	0.24	1242 1248	0%	0%
tooth paste	105-091514-0900	0.23	1242	0%	0.7%
crosshair	015-091814-0935	0.22	1254 1260	9.6%	0%
WSDOT Salt Brine Soln. LAB DUP	B6C0153-DUP1	0.20	1254	0.7%	0.02%
CaCl Deicer FIELD DUP	Replicate #2	0.18	1260	22%	0%
auto grease	024-082714-1504	0.16	1242 1260	11%	0%
MgCl Deicer	P301-122215-0830	0.15	1254 1260	0%	0%
wood fiber hydromulch (green dyed)	202-030915-1242	0.15	1242	24%	0%
used motor oil	replicate #1	0.13	1260	5.5%	13%
SWARCO Yellow Road Paint	P408-082416-1047	0.13	1242	40%	4.5%
weedar 64 (2,4-D)	012-091814-0930	0.13	1242	0%	0%
CaCl Deicer	V310-021616-1415	0.12	1254	1.0%	0.1%
WSDOT Salt Brine Soln.	V313-022316-1018	0.12	1254	2.9%	0.4%
COS Road Salt	P311-021616-1435	0.11	1248	32%	10%
WSDOT Salt Brine Soln.	P313-022316-1018	0.11	1248	0%	0%
asphalt release agnt.	027-101014-0950	0.11	1242	35%	0%
laundry det.	102-101314-1100	0.10	1242	35%	0.1%
recycled motor oil LAB DUP	016-082714-1459 DUP	0.09	1260	4.9%	0%
recycled motor oil	016-082714-1459	0.08	1254	0%	0%
Hotsy Soap	010-090914-0906	0.08	1260	0%	3.5%
weedar 64 (2,4-D)	012-091814-0930 DUP	0.08	1242	0%	0.5%
Simple Green	011-090914-0908	0.08	1242	24%	2.1%

Product	Sample ID	R2	Aroclor(s)	PCB 11	PCB 209
dust suppressent	023-101014-1035	0.08	1248 1260	2.7%	0.01%
MgCl Deicer	P309-021016-0910	0.07	1248	0%	0%
asphalt release agnt.	027-101014-0950 DUP	0.07	1242	39%	0.4%
Sherwin Williams Yellow Road Paint	P407-082416-1008	0.03	1242	55%	0%
Enis-Flint White Road Paint	P402-091216-1050	0.03	1242	49%	0%
used motor oil	018-082714-1455	0.03	1260	8.3%	0%
Sherwin Williams White Road Paint	Replicate #3.1	0.03	1242	13%	0%
yl rd paint (ennis)	001-091014-1335	NS		6.1%	31%
yl rd paint (ennis)	replicate #2	NS		25%	12%
yl rd paint (sherwin)	002-082514-1039	NS		75%	0.1%
wt rd paint (ennis)	003-091014-1340	NS		14%	49%
wt rd paint (ennis)	replicate #3	NS		18%	44%
wt rd paint (sherwin)	004-082514-1035	NS		26%	0%
wt rd paint LAB DUP	004-082514-1035 DUP	NS		24%	0.9%
hydrant paint	005-100314-1430	NS		21%	2.1%
spray paint (green)	006-082714-1045	NS		5.9%	65%
Deicer	008-091814-0925	NS		1.5%	0%
Deicer	replicate #4	NS		0%	0.1%
portfolio 4f (pesticide)	013-091814-0940	NS		0%	0.4%
gasoline	020-082114-1104	NS		0%	0%
gasoline	020-082114-1104 DUP	NS		0%	0.3%
EADA (dust sup.)	021-100214-1420	NS		28%	0%
SSR1 Asphalt Tack	025-091814-1006	NS		30%	0%
PVC Pipe	029-100314-1330	NS		4.5%	26%
dry yl rd paint	032-091014-1335	NS		7.9%	30%
dry wt rd paint	033-091014-1340	NS		14%	57%
dry wt rd paint LAB DUP	033-091014-1340 DUP	NS		15%	45%
shampoo	104-101314-1100	NS		60%	0%
wood fiber hydromulch (undyed)	203-030915-1241	NS		33%	0.2%

Product	Sample ID	R2	Aroclor(s)	PCB 11	PCB 209
green survey marker (AERVOE)	204-030915-1241	NS		5.4%	61%
green survey marker (AERVOE)	204-030915-1241 DUP	NS		5.6%	69%
MgCl Deicer FIELD DUP	Replicate #1	NS		29%	0%
MgCl Deicer LAB DUP	P309-021016-0910 DUP	NS		0%	24%
Enis-Flint White Road Paint	Replicate #2.1	NS		61%	18%
Sherwin Williams White Road Paint	P403-082416-1030	NS		75%	0%
SWARCO White Road Paint	P404-082416-1110	NS		5.0%	95%
SWARCO White Road Paint	Replicate #4.1	NS		1.7%	97%
Enis-Flint Yellow Road Paint	P406-091216-1040	NS		84%	0%
Enis-Flint Yellow Road Paint	Replicate #6.1	NS		87%	0%
Enis-Flint Yellow Road Paint LAB DUP	Replicate #6 DUP.1	NS		91%	0%
Sherwin Williams Yellow Road Paint	Replicate #7	NS		84%	0%
SWARCO Yellow Road Paint	Replicate #8	NS		89%	4.3%
SWARCO Yellow Road Paint LAB DUP	Replicate #8 DUP	NS		87%	4.4%

NS = not significant

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CURRICULUM VITAE

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EDUCATION

Ph.D. 1999, The Johns Hopkins University, Department of Geography and Environmental Engineering

B.A. 1991, Wittenberg University, Springfield, OH, Chemistry

PROFESSIONAL EXPERIENCE

2017-present	Professor, Rutgers University, Department of Environmental Sciences
2018-present	Graduate program director, Environmental Science
2012-2018	Undergraduate Program Director, Environmental Science (~140 students)
2010-2017	Associate Professor, Rutgers University, Department of Environmental Sciences
2004-2010	Assistant Professor, Rutgers University, Department of Environmental Sciences
2002-2004	Assistant Research Professor, Rutgers University, Department of Environmental Sciences
2001-2002	Laboratory Researcher I, Rutgers University, Department of Environmental Sciences
1998-2001	Camille and Henry Dreyfus Post-Doctoral Fellow in Environmental Chemistry, Rutgers University, Department of Environmental Sciences
1991-1993	Quality Assurance Chemist, Hoechst-Roussel Pharmaceuticals Inc., Somerville, NJ

RESEARCH INTERESTS

Fate of anthropogenic chemicals, particularly PCBs and other semivolatile organic contaminants (SOCs), in water, air, sediments, and biota. Source apportionment of contaminants, management and analysis of large data sets.

HONORS AND AWARDS

Excellence in Review Award from *Environmental Science and Technology* 2014
Camille and Henry Dreyfus Foundation Post-Doctoral Fellowship in Environmental Chemistry
ACS Environmental Division Graduate Student Paper Award 1998
ACS Environmental Division Graduate Student Award 1998
Graduate Student Fellowship, National Science Foundation, 1994-1997
Dean’s Fellowship, Johns Hopkins University, Whiting School of Engineering, 1993, 1998
National Merit Scholar, 1987-1991
Graduated Summa Cum Laude from Wittenberg University

PROFESSIONAL AFFILIATIONS
American Chemical Society, Environmental Chemistry Division (ACS)
Society of Environmental Toxicology and Chemistry (SETAC)
Association of Environmental Engineering and Science Professors (AEESP)
Association for Women in Science (AWIS)
Environmental Sciences Affiliate of the New York Academy of Sciences

EDUCATIONAL ACTIVITIES
Primary teaching

2015-present	11:375:197 *Environmental Science Literacy* (house course for the Environmental Science LLC, Douglass Project for women in STEM)	Instructor
2011- present	11:375:340 *Environmental Applications of Organic Chemistry*	Instructor
2001- 2013	11:375:310 *Analytical Environmental Chemistry Laboratory*	Instructor
2000 - present	16:375:522 *Environmental Organic Chemistry*	Instructor

Other teaching

2010-present	01:556:130 Introduction to Scientific Research (ISR)	Research mentor
2012	11:015:103 *Portals to Academic Study Success*	Instructor
2010-2011	11:375:432 *Readings in Environmental Science* (house course for the Douglass Project for women in STEM)	Co-instructor (50%)
2009	16:375:540 *Atmospheric Chemistry*	Instructor
2007	11:375:423/523 *Environmental Fate And Transport*	Co-instructor (50%)
2006	375:454 *Soil Biological Processes*, cross-listed with 375:573 *Soil Ecosystem Processes*	Co-instructor (40%)
2005 – 2006	01:160:200 *Introduction to Research in Chemistry*	Research mentor
1998	*Chemistry of Environmental Issues* (John Hopkins University)	Teaching assistant

MEDIA COVERAGE
ABC News Good Morning America: Is the Color Yellow Dangerous? (interview about PCBs in pigments). 2/23/2014
Scientific American: "Yellow Pigments in Clothing and Paper Contain Long-Banned Chemical" 2/20/2014
Yahoo.com: "PCBs banned for decades but still lurking in some yellow products" 2/25/2014
Newsmax.com "Many Yellow Items Still Contain Banned PCB Chemical, Study Says." 2/21/2014
Environmental Health News: "Yellow pigments in clothing, paper contain long-banned PCB." 2/20/2014
Food Packaging Forum: "PCB-11 detected in clothing and paper samples." 2/21/2014
Environmental Health Perspectives: "Nonlegacy PCBs: Pigment Manufacturing By-Products Get a Second Look." Volume 121, Issue 3, Pages A87-A93. March 2013.

IMPACTS

The State of Washington in 2013 passed legislation (bill 6086) that requires the state to purchase only products that do not contain PCBs. This legislation is aimed in large part at PCBs in pigments, and my work in this area raised awareness and indirectly led to this legislation.

SERVICE

Mentoring

Mentoring committee member for Benjamin Lintner (Assistant Professor) and Jeffra Schaefer (Assistant Research Professor) in the Department of Environmental Science, Rutgers

Founder, *Beautiful Untenured Female Faculty* (BUFF), a peer-to-peer networking group for female faculty at SEBS

Working with High School students on various projects for science fairs, including the Partners in Science program (Liberty Science Center); North Jersey Regional Science Fair; a competition at Monmouth University; and the Young Science Achievers Program. Eleven students mentored so far (2006-present)

Mentored more than 50 undergraduate interns

Professional Societies

Session Chair (with Nicole Fahrenfeld). "Advances in Understanding PPCP Fate in Wastewater Collection & Treatment Systems." American Chemical Society 252nd National Meeting, August 21-25, 2016, Philadelphia, PA.

Member of the 2005 SETAC North America Annual Meeting Program Committee

Session Chair (with Miriam Diamond). "Urban Contaminants: Sources, Composition, Fate from a Multimedia Perspective." SETAC North America 28th Annual Meeting, November 11-15, 2007, Milwaukee, WI.

Session Chair (with DE Fennell) "Fate of Persistent Organic Pollutants in Urban Systems." Division of Environmental Chemistry, 234th American Chemical Society (ACS) National Meeting, August 19-23, 2007, Boston, MA.

University

Search committee, TT appointment in Environmental Microbiology, 2015-2016
Strategic Planning Committee for Douglass Residential College, 2015
Douglass Project STEM Summer Stipend selection committee, 2015
Undergraduate Program Director, Environmental Sciences, 2012-present
Department of Environmental Sciences, Equipment Committee, 2014-2017
Graduate Program in Environmental Sciences, Admissions Committee, 2012-2015
New Brunswick Faculty Council, 2009-2012
Search committee, broad faculty announcement in Environmental Sciences, 2008-2010
Chair, Environmental Sciences Graduate Program Curriculum Committee, 2006-2009
Department of Environmental Sciences Space Committee, 2006-2009
Dean's Ad-Hoc Committee on Childcare, 2005

National Panels

Member, Science and Technical Advisory Committee (STAC), New York/New Jersey Harbor & Estuary Program. 2017-present

Science Advisor, *Made Safe* (http://madesafe.org/), formerly *Non-Toxic Certified*, 2015-present
Reviewer - Green-Duwamish River Watershed PCB Congener Study: Phase 1, 2015
Advisor to the Spokane River Regional Toxics Taskforce, Spokane, WA, 2012-present
Served as an expert witness for the State of Washington (Department of Ecology) at the August 2012 meeting of the Environmental Council of States. I presented a short lecture on the problem of inadvertent production of PCBs in pigments.
Member of Expert Panel advising the Delaware River Basin Commission on establishment of a TMDL for PCBs in the Delaware River 2001-2009

Other
Proposal reviewer for the Hudson River Foundation: Hudson River Fund and Mark Bain Graduate Fellowships
Reviewer for the Arctic Monitoring and Assessment Programme (AMAP) review of Non-Aroclor and Byproduct PCBs 2016
Faculty Advisor, Futurology Club, 2015-2016
Author of Wikipedia entry on Diarylide Pigment
Proposal reviewer, National Science Foundation, Petroleum Research Fund, and U.S. Civilian Research and Development Foundation (CRDF).
Reviewer for *Environmental Science and Technology, Atmospheric Environment, Environmental Engineering and Science, Journal of the Air & Waste Management Association, Industrial and Engineering Chemistry Research, Water Air and Soil Pollution*, and *Science of the Total Environment.*
Poster session organizer, Gordon Conference on Environmental Sciences: Water, 2000.

PUBLICATIONS
Peer-Reviewed (* - author is a current or former student of mine; § work performed as an undergraduate intern)

1. **Rodenburg, LA**; Winstanley, I; Wallin JM. Source Apportionment of Polychlorinated Biphenyls in Atmospheric Deposition in the Seattle, WA, USA area measured with Method 1668. *Archives of Environmental Contamination and Toxicology*. **2019**, 77, 188–196.
2. **Rodenburg, LA**; Delistraty, DA. Alterations in Fingerprints of Polychlorinated Biphenyls in Benthic Biota at the Portland Harbor Superfund Site (Oregon, USA) Suggest Metabolism. *Chemosphere*. **2019**, *223*, 74-82.
3. Capozzi, SL*; Jing, R; **Rodenburg, LA**; Kjellerup, BV. Positive Matrix Factorization analysis shows dechlorination of polychlorinated biphenyls during domestic wastewater collection and treatment. *Chemosphere*. **2019**, *216*, 289-296.
4. Krumins, V; Sun, W; Guo, J*; Capozzi, S*; Fennell, DE; **Rodenburg LA**. Sewer Sediment Bacterial Communities Suggest Potential to Transform Persistent Organic Pollutants. *Water Environ. Res.* **2018,** *90(12)*, 2022-2029.
5. Capozzi, SL*; **Rodenburg, LA**; Krumins, V; Fennell, DE; Mack, EE. Using positive matrix factorization to investigate microbial dehalogenation of chlorinated benzenes in groundwater at a historically contaminated site. *Chemosphere* **2018**, *211*, 515-523.

6. **Rodenburg, LA**; Dewani, Y*; Haggblom, MM; Kerkhof, LJ; Fennell, DE. Forensic Analysis of Polychlorinated Dibenzo-p-Dioxin and –Furan Fingerprints to Elucidate Dechlorination Pathways. *Environ. Sci. Technol.* **2017,** *51*, 10485-10493.
7. Praipipat, P*; Meng, QY; Miskewitz, RJ; **Rodenburg, LA**. Source Apportionment of Atmospheric Polychlorinated Biphenyls in New Jersey 1997- 2011. *Environ. Sci. Technol.* **2017**, *51,* 1195-1202.
8. **Rodenburg, LA**; Ralston, DK. Historical sources of polychlorinated biphenyls to the sediment of the New York/New Jersey Harbor. *Chemosphere*. **2017,** *169*, 450-459.
9. **Rodenburg, LA**; Krumins, V; Curran, JC. Microbial dechlorination of polychlorinated biphenyls, dibenzo-p-dioxins, and -furans at the Portland Harbor superfund site, Oregon, USA. *Environ. Sci. Technol.* **2015** *49,* 7227−7235.
10. **Rodenburg, LA**; Guo J*; Christie, RM. Polychlorinated biphenyls (PCBs) in pigments: inadvertent production and environmental significance. *Coloration Technology*. **2015,** *131,* 353–369. **Feature Article**
11. **Rodenburg, LA**; Delistraty, D; Meng, Q. Polychlorinated biphenyl congener patterns in fish near the Hanford Site (Washington State, USA). *Environ. Sci. Technol.* **2015**, *49*, 2767–2775.
12. Japhe, T., Zhdanova, K., **Rodenburg, L**., Roberson, L., Navarro, AE. Factors affecting the Biosorption of 2-Chlorophenol using spent tea leaf wastes as adsorbents. *J. J Environ. Sci.,* **2015**, *1 (2):* 010.
13. Xiong, Y; Krogmann, U; Mainelis, G; **Rodenburg, LA**; Andrews, CJ. Indoor air quality in green buildings: A case-study in a residential high-rise building in the northeastern United States. *Journal Of Environmental Science And Health, Part A.* **2014**, *50(3)*, 225-242.
14. Guo, J*; Capozzi, SL*; Kraeutler, TM*§; Rodenburg, LA. Global distribution and local impacts of inadvertently generated polychlorinated biphenyls in pigments. *Environ. Sci. Technol.* **2014**, *48*, 8573-8580.
15. Zhen, H.; Du, S*; **Rodenburg, L.A.**; Mainelis, G.; Fennel, D.E. Reductive Dechlorination of 1,2,3,7,8-Pentachlorodibenzo-p-dioxin and Aroclor 1260, 1254 and 1242 by a Mixed Culture Containing *Dehalococcoides mccartyi* strain 195. *Water Research*. **2014**, *52*, 51-62.
16. **Rodenburg, LA**; Meng, Q; Yee, D.; Greenfield, BK. Evidence for photolytic and microbial debromination of brominated diphenyl ether flame retardants in San Francisco Bay sediment. *Chemosphere*. **2014**, *106*, 36-43.
17. Praipipat, P.*; **Rodenburg, L.A**.; Cavallo, G.J. Source Apportionment of Polychlorinated Biphenyls in the sediments of the Delaware River. *Environ. Sci. Technol.* **2013**, *47* (9), 4277–4283.
18. **Rodenburg, L.A.**; Meng, Q. Source Apportionment of Polychlorinated Biphenyls in Chicago Air from 1996-2007. *Environ. Sci. Technol.* **2013**, *47 (8)*, 3774–3780.
19. Liu, H.; Park, J-W.; Fennell, D. E.; **Rodenburg, L. A.**; Verta, M.; Häggblom, M.M. Microbial Reductive Dechlorination of Weathered Polychlorinated Dibenzofurans in Kymijoki Sediment Mesocosms. *Chemosphere*. **2013**, *92(2)*, 212-221.
20. Sandy, A.L.*; Guo, J.*; Miskewitz, R.J.; McGillis, W.R.; **Rodenburg, L.A.** Mass transfer coefficients for volatilization of polychlorinated biphenyls from the Hudson River, New York measured using micrometeorological approaches. *Chemosphere*. **2012**, *90(5)*, 1637-1643.
21. **Rodenburg, L.A.**; Du, S.*; Lui, H.; Guo, J.*; Oseagulu, N.* §; and Fennell, D. E. Evidence for dechlorination of polychlorinated biphenyls and polychlorinated dibenzo-p-dioxins and –

furans in wastewater collection systems in the New York metropolitan area. *Environ. Sci. Technol.* **2012,** *46*, 6612–6620.

22. Sandy, A.L.*; Guo, J.*; Miskewitz, R.J.; McGillis, W.R.; **Rodenburg, L.A.** Fluxes of polychlorinated biphenyls volatilizing from the Hudson River, New York measured using micrometeorological approaches. *Environ. Sci. Technol.* **2012**, *46*, 885-891.
23. **Rodenburg, L.A.**; Du, S.*; Xiao, B.; Fennell, D.E. Source Apportionment of Polychlorinated Biphenyls in the New York/New Jersey Harbor. *Chemosphere*. **2011**, *83*, 792–798.
24. Park, J-W.; Krumins, V.; Kjellerup, B.V.; Fennell, D. E.; **Rodenburg, L.A**.; Sowers, K.R.; Kerkhof, L.J.; Häggblom, M. M. The effect of co-substrate activation on indigenous and bioaugmented PCB dechlorinating bacterial communities in sediment microcosms. *Appl. Microbiol. Biotechnol.* **2011**, *89*, 2005-2017.
25. **Rodenburg, L.A.**; Fennell, D.E.; Du, S.*; Cavallo, G.J. Evidence for Widespread Dechlorination of Polychlorinated Biphenyls in Groundwater, Landfills, And Wastewater Collection Systems. *Environ. Sci. Technol.* **2010**, *44*, 7534-7540.
26. Cwiertny, D.; Arnold, W.A.; Kohn, T.; **Rodenburg, L.A.**; Roberts, A.L. Reactivity of Alkyl Polyhalides toward Granular Iron: Development of QSARs and Reactivity Cross Correlations for Reductive Dehalogenation. *Environ. Sci. Technol.* **2010,** *44*, 7928–7936.
27. **Rodenburg, L.A.**; Valle, S. N.; Panero, M. A.; Munoz, G. R.; Shor, L. M. Mass Balances on Selected Polycyclic Aromatic Hydrocarbons (PAHs) in the New York/New Jersey Harbor. *Journal of Environmental Quality*. **2010**, *39,* 642-653.
28. **Rodenburg, L.A.**; Guo*, J.; Du*, S.; Cavallo, G.J. Evidence for Unique and Ubiquitous Environmental Sources of 3,3'-dichlorobiphenyl (PCB 11). *Environ. Sci. Technol.* **2010**, *44*, 2816–2821. *DOI: 10.1021/es901155h*
29. Krumins, V.; Park, J.W.; Son, E.K.; **Rodenburg, L.A.;** Kerkhof, L.J.; Haggblom, M.M.; Fennell, D.E. PCB Dechlorination Enhancement in Anacostia River Sediment. *Water Research.* **2009,** *43 (18)*, 4549-4558.
30. Du*, S; Wall*, SJ; Cacia*§, D; **Rodenburg, LA.** Passive Air Sampling for Polychlorinated Biphenyls in the Philadelphia, USA Metropolitan Area. *Environ. Sci. Technol.* **2009**, *43,* 1287-1292.
31. Du*, S; Belton, T. J.; **Rodenburg, L.A.** Source Apportionment of PCBs in the Tidal Delaware River. *Environ. Sci. Technol.* **2008**, *42*, 4044–4051.
32. Zarnadze*, A.; **Rodenburg, L.A.** Water Column Concentrations and Partitioning of Polybrominated Diphenyl Ethers in the New York/New Jersey Harbor, USA. *Environmental Toxicology and Chemistry*. **2008**, *27 (8)*, 1636–1642. DOI: 10.1897/07-619
33. Polidori, A.; Turpin, B. J.; Davidson, C. I.; **Rodenburg, L. A.**; Maimone, F. Organic $PM_{2.5}$: Fractionation By Polarity, FTIR Spectroscopy, And OM/OC Ratio For The Pittsburgh Aerosol. *Aerosol Science and Technology*. **2008**, *42(3)*, 233-246.
34. Yan, S.; **Rodenburg, L. A.**; Dachs, J.; Eisenreich, S. J. Seasonal air-water exchange fluxes of polychlorinated biphenyls in the Hudson River Estuary. *Environmental Pollution.* **2008**, *152*, 443-451. doi:10.1016/j.envpol.2007.06.074
35. Du*, S.; **Rodenburg, L. A.** Source Identification of Atmospheric PCBs in Philadelphia/Camden Using Positive Matrix Factorization Followed by the Potential Source Contribution Function. *Atmospheric Environment.* **2007**, *41*, 8596–8608.

36. Asher, B. J.; Wong, C. S.; **Rodenburg, L. A.** Chiral Source Apportionment of Polychlorinated Biphenyls To The Hudson River Estuary Atmosphere And Food Web. *Environ. Sci. Technol.* **2007**, *41*, 6163-6169.
37. Rowe*, A. A.; **Totten, L. A.**; Cavallo, G. J.; Yagecic, J. R. Watershed Processing of Atmospheric Polychlorinated Biphenyl Inputs. *Environ. Sci. Technol.* **2007,** *41*, 2331-2337.
38. Rowe*, A. A.; **Totten, L. A.**; Xie, M.; Fikslin, T. J.; Eisenreich, S. J. Air-water exchange of polychlorinated biphenyls in the Delaware River. *Environ. Sci. Technol.* **2007**, *41*, 1152-1158.
39. **Totten, L. A**.; Stenchikov, G. L.; Gigliotti, C. L.; Lahoti, N.; Eisenreich, SJ. Measurement and Modeling of Urban Atmospheric PCB Concentrations On A Small (8 km) Spatial Scale. *Atmospheric Environment*. **2006**, *40 (40)*, 7940-7952.
40. Yi, S-M; **Totten, L.A.;** Thota*, S.; Yan, S.; Offenberg, J. H.; Eisenreich, S.J.; Graney, J; Holsen, T.M. Atmospheric Dry Deposition of Trace Elements Measured Around the Urban and Industrially Impacted NY-NJ Harbor. *Atmospheric Environment.* **2006,** *40*, 6626–6637.
41. **Totten, L.A.**; Panangadan*, M.; Eisenreich, S.J.; Cavallo, G.J.; Fikslin, T.J. Direct and Indirect Atmospheric Deposition of PCBs to the Delaware River Watershed. *Environ. Sci. Technol.* **2006**, *40 (7)*, 2171-2176.
42. Gigliotti, C.L.; **Totten**, L.A.; Offenberg, J.H.; Dachs, J.; Reinfelder, J.R.; Nelson, E.D.; Glenn, T.R. IV; Eisenreich, S.J. Atmospheric Concentrations and Deposition of PAHs to the Hudson River Estuary. *Environ. Sci. Technol.* **2005**, *39*, 5550-5559.
43. Gioia, R.; Offenberg, J. H.; Gigliotti, C.L.; **Totten, L.A.**; Du*, S.; Eisenreich, S.J. Atmospheric Concentrations and Deposition of Organochlorine Pesticides in the US Mid-Atlantic Region. *Atmospheric Environment.* **2005**, *39 (12),* 2309-2322.
44. **Totten, L. A.**; Gigliotti, C. L.; VanRy, D. A.; Offenberg, J. H.; Nelson, E. D.; Dachs, J.; Reinfelder, J. R.; Eisenreich, S. J. Atmospheric Concentrations and Deposition of PCBs to the Hudson River Estuary. *Environ. Sci. Technol.* **2004**, *38*, 2568-2573.
45. Koelliker, Y.; **Totten, L. A.**; Gigliotti, C. L.; Offenberg, J. H.; Reinfelder, J. R.; Zhuang, Y.; Eisenreich, S. J. Atmospheric Wet Deposition of Total Phosphorus in New Jersey. *Water, Air, and Soil Pollution*. **2004**, *154 (1-4)*, 139-150.
46. **Totten, L. A.**; Gigliotti, C. L.; Offenberg, J. H.; Baker, J. E.; Eisenreich, S. J. Re-evaluation of Air-Water Exchange Fluxes of PCBs in Green Bay and Southern Lake Michigan. *Environ. Sci. Technol.* **2003,** *37,* 1739-1743.
47. Van Ry, D. A.; Gigliotti, C. L.; Glenn, T. R. IV; Nelson, E. D.; **Totten, L. A.**; Eisenreich, S. J. Wet Deposition of Polychlorinated Biphenyls in Urban and Background Areas of the Mid-Atlantic States. *Environ. Sci. Technol.* **2002**, *36,* 3201-3209.
48. Dachs, J.; Glenn, T. R.; Gigliotti, C. L.; Brunciak, P.; **Totten, L. A.**; Nelson, E. D.; Franz, T. P.; Eisenreich, S. J. Processes driving the short-term variability of polycyclic aromatic hydrocarbons in the Baltimore and northern Chesapeake Bay atmosphere, USA. *Atmospheric Environment* **2002**, *36*, 2281-2295.
49. Naumova, Y. Y.; Eisenreich, S. J.; Turpin, B. J.; Weisel, C. P.; Morandi, M. T.; Colome, S. D.; **Totten, L. A.**; Stock, T. H.; Winer, A. M.; Alimokhtari, S.; Kwon, J.; Shendell, D.; Jones, J.; Maberti, S.; Wall, S. J. Polycyclic aromatic hydrocarbons in the indoor and outdoor air of three cities in the US. *Environ. Sci. Technol.* **2002**, *36*, 2552-2559.
50. **Totten, L. A.**; Eisenreich, S. J.; Brunciak, P. Evidence for destruction of PCBs by the OH radical in urban atmospheres. *Chemosphere* **2002**, *47*, 735-746.

51. Gigliotti, C. L.; Brunciak, P. A.; Dachs, J.; IV, G. T. R.; Nelson, E. D.; **Totten, L. A.**; Eisenreich, S. J. Air-Water Exchange of Polycyclic Aromatic Hydrocarbons in the NY-NJ Harbor Estuary. *Environ. Toxicol. Chem.* **2001**, *21*, 235-244.
52. **Totten, L. A.**; Brunciak, P. A.; Gigliotti, C. L.; Dachs, J.; Glenn. T. R., IV; Nelson, E. D.; Eisenreich, S. J. Dynamic Air-Water Exchange of Polychlorinated Biphenyls in the NY-NJ Harbor Estuary**.** *Environ. Sci. Technol.* **2001**, *35*, 3834-3840.
53. **Totten, L. A.**; Roberts, A. L. Calculated one- and two-electron reduction potentials and related molecular descriptors for reduction of alkyl and vinyl halides in water. *Crit. Rev. Environ. Sci. Technol.* **2001**, *31*, 175-221.
54. **Totten, L. A.**; Roberts, A. L.; Jans, U. Alkyl bromides as probes of reductive dehalogenation: Reactions of stereochemical probes with zero-valent metals. *Environ. Sci. Technol.* **2001**, *35*, 2268-2274.
55. Roberts, A. L.; **Totten, L. A.**; Arnold, W. A.; Burris, D. R.; Campbell, T. J. Reductive elimination of chlorinated ethylenes by zero-valent metals. *Environ. Sci. Technol.* **1996**, *30*, 2654-2659.

Other

1. **Rodenburg, LA** and Leidos. Green-Duwamish River Watershed Addendum to PCB Congener Study: Phase 2 Source Evaluation Report. Prepared for State of Washington Department of Ecology Toxics Cleanup Program. 2018.
2. **Rodenburg,** LA and Leidos. Green-Duwamish River Watershed PCB Congener Study: Phase 2 Initial Data Assessment. Prepared for State of Washington Department of Ecology Toxics Cleanup Program. 2017.
3. **Rodenburg, LA** and Leidos. Green-Duwamish River Watershed PCB Congener Study: Phase 2 Source Evaluation. Prepared for State of Washington Department of Ecology Toxics Cleanup Program. 2017.
4. Du*, S.; **Rodenburg, LA**. "Measurement and Modeling of Semivolatile Organic Compounds in Local Atmospheres." In: *Biophysico-Chemical Processes of Anthropogenic Organic Compounds in Environmental Systems.* Baoshan Xing, Ed. Pp. 149-184, 2010.
5. **Totten, LA.** "The Importance of Atmospheric Interactions to PCB cycling in the Hudson and Delaware River Estuaries." In: *PCBs: Human and Environmental Disposition and Toxicology*. LG Hansen and LW Robertson, Eds. University of Illinois Press, Chicago, IL, pp. 51-59, 2008.
6. **Rodenburg, LA.** "Appendix B: Summary Of Mass Balances On Selected Polycyclic Aromatic Hydrocarbons (PAHs) In The NY/NJ Harbor Estuary." In: *Pollution Prevention And Management Strategies For Polycyclic Aromatic Hydrocarbons In The New York/New Jersey Harbor.* Report by the New York Academy of Sciences, pp. 139-141, 2007. Available at: http://www.nyas.org/programs/harbor.asp
7. **Totten, L. A.** "Present-Day Sources and Sinks for Polychlorinated Biphenyls (PCBs) in the Lower Hudson River Estuary," In: *Pollution Prevention And Management Strategies For Polychlorinated Biphenyls In The New York/New Jersey Harbor.* Report by the New York Academy of Sciences, pp. 84-96, 2005. Available at: http://www.nyas.org/programs/harbor.asp
8. **Totten, L. A.;** Eisenreich, S.J.; Gigliotti, C. L.; Dachs, J.; VanRy, D.A.; Yan, S.; Aucott, M. "Atmosphere Deposition of PCBs and PAHs to the New York/New Jersey Harbor Estuary."

In: *The Hudson River Estuary*. J. Levinton and J. R. Waldman, Eds. Cambridge University Press, New York, pp. 398-412, 2006.

9. Baker, J. E.; **Totten, L. A.**; Gigliotti, C. L.; Offenberg, J. H.; Eisenreich, S. J.; Bamford, H. A.; Huie, R. E.; Poster, D. L. Response to Comment on "Reevaluation of Air-Water Exchange Fluxes of PCBs in Green Bay and Southern Lake Michigan." *Environ. Sci. Technol*. **2004,** *38*, 1629-1632.
10. **Totten, L. A.**; Assaf-Anid, N. M. "Abiotic Dehalogenation by Metals." In: *Dehalogenation: Microbial Processes and Environmental Application*. Haggblom, M.M.; Bossert, I. D., Eds. Kluwer: New York, 2002.
11. Eisenreich, S. J.; Gigliotti, C.L.; Brunciak, P. A.; Dachs, J.; Glenn IV, T. R.; Nelson, E. D.; **Totten, L. A.**; VanRy, D.A. "Persistent Organic Pollutants in the Coastal Atmosphere of the Mid-Atlantic States-USA." In: *Persistent Bioaccumulative Toxic Organic Compounds*. R. Lipnick, Ed. American Chemical Society Symposium Series: Washington, D. C., 2000.

PRESENTATIONS

Invited lectures

Rodenburg, LA. PCBs: An Update. Webinar presented September 25, 2017 for the Office of Continuing Professional Education. Available online at: youtube.com

Rodenburg, LA. Why are PCBs and PCDD/Fs dechlorinated by bacteria in some places but not others? Oral presentation. SETAC 38th Annual Meeting in North America, Minneapolis, MN, November 12-16, 2017.

Rodenburg, LA. Green-Duwamish River Watershed PCB Congener Study: Phase 2 Initial Data Assessment. Webinar for the Spokane River Toxics Taskforce. April 26, 2017.

Rodenburg, LA. Green-Duwamish River Watershed PCB Congener Study: Phase 2 Initial Data Assessment. Green-Duwamish Watershed Pollutant Loading Assessment Technical Advisory Committee. Tukwila, WA. March 15, 2017.

Rodenburg, LA. Green-Duwamish River Watershed PCB Congener Study: Phase 2 Initial Data Assessment. US EPA Region 10 and Washington State Department of Ecology. Seattle, WA. March 14, 2017.

Rodenburg, LA. Environmental Data Mining, or How to do Research with No Money. Special seminar, University of Maryland College Park, Department of Civil and Environmental Engineering. December 7, 2015.

Rodenburg, LA. Environmental Data Mining, or How to do Research with No Money. Special seminar, The Johns Hopkins University, Department of Geography and Environmental Engineering. December 8, 2015.

Rodenburg, LA. Microbial Dechlorination of PCBs—it's not just for sediments any more. 250th ACS National Meeting, Boston, MA, August 16-20, 2015.

Rodenburg, LA. Identifying non-Aroclor PCB sources through fingerprinting. Spokane River Regional Toxics Taskforce PCB Workshop. January 12-13, 2015, Spokane, WA.

Rodenburg, LA. Fingerprinting And Source Apportionment Of PCBs And BDEs. Eighth International Conference on Remediation and Management of Contaminated Sediments (Battelle), January 12-15, 2015, New Orleans, LA.

Rodenburg, LA., Krumins, V.; Crowe-Curran, J. Dechlorination of PCBs in the groundwater of the Portland Harbor. Teleconference presentation to Region 10 EPA. January 5, 2015.

Rodenburg, LA. Identifying non-Aroclor PCB sources through fingerprinting. 8th International PCB Workshop, October 5-9, 2014, Woods Hole, MA.

Guo, J.*; Praipipat, P.*; **Rodenburg, LA.** PCBs in pigments, inks, and dyes: Documenting the problem. 17th Annual Green Chemistry & Engineering Conference (American Chemical Society Green Chemistry Institute). June 19, 2013.

Rodenburg, LA. PCBs in consumer products, or how to do research with no money. Oral presentation, Department of Civil and Environmental Engineering, Temple University. March 22, 2013. Philadelphia, PA.

Rodenburg, LA. Stormwater PCBs: Tales from two urban estuaries. Oral presentation at Spokane River Regional Toxics Task Force. June 5-6, 2012. Spokane, WA.

Rodenburg, LA. Microbial dechlorination of persistent organic pollutants in sewers. Oral presentation, Department of Civil and Environmental Engineering, University of Houston. July 9, 2012. Houston, TX.

Rodenburg, LA. Dechlorination of PCBs and dioxins in sewers: Applications to the Passaic River. Special seminar, Montclair State University. March 21, 2012. Montclair, NJ.

Rodenburg, LA; Cacia, DM. Are urban atmospheric PCB concentrations going down? Oral presentation at the 242nd ACS National Meeting, August 28-September 1, 2011, Denver, CO.

Rodenburg, LA; Du, S; Oseagulu, NU; Guo, J; Fennell, DE. Evidence for dechlorination of PCBs and PCDD/Fs in sewers. Oral presentation at the 242nd ACS National Meeting, August 28-September 1, 2011, Denver, CO.

Rodenburg, LA. Water Quality Management in New Jersey's Waterways. Invited seminar, Fermentation Club, Rutgers University, April 3, 2009.

Rodenburg, LA. Diurnal Cycling of Persistent Organic Pollutants in the Atmosphere. Invited seminar, workshop on "Diurnal (Diel) Cycling of Chemical Constituents in Surface Water and Related Media—Scientific and Regulatory Considerations." New Jersey Department of Environmental Protection, December 12, 2008. Trenton, NJ.

Rodenburg, LA. History of contamination in the Hudson River. Invited seminar, Guangzhou Institute of Geochemistry-South China University of Technology Collaborative Workshop. November 13-15, 2008, Guangzhou, PRC.

Rodenburg, LA. PCBs in the Delaware River. Invited seminar, Guangzhou Institute of Geochemistry-South China University of Technology Collaborative Workshop. November 13-15, 2008, Guangzhou, PRC.

Rodenburg, LA. Water Quality Management in New Jersey's Waterways. Invited seminar, School of Environmental Science and Public Health, Wenzhou Medical College. November 18, 2008, Wenzhou, PRC.

Rodenburg, LA. Investigating Atmospheric PCB Source Types, Locations, And Magnitudes In Urban Areas Of New Jersey. Invited presentation, Fifth PCB Workshop: New Knowledge Gained From Old Pollutants. May 18-22, 2008, Iowa City, Iowa.

Rodenburg, LA. The TMDL for PCBs in the Delaware River. Invited seminar, University of Minnesota, Department of Civil and Environmental Engineering, Minneapolis, MN. April 24, 2008.

Rodenburg, LA. The TMDL for PCBs in the Delaware River. Invited seminar, Kettering College of Medical Arts, Kettering, OH. March 27, 2008.

Rodenburg, LA. Atmospheric deposition to the Hudson River. Invited lecture, New York University, November 6, 2007.

Rodenburg, LA; Du, S.; Xiao, B.; Belton, T.; Fennell, D. E. Source Apportionment of Urban PCBs. Platform presentation SETAC 28th Annual Meeting in North America, November 11-15, 2007, Milwaukee, WI.

Totten, LA. PBDEs in the air and water of the NY/NJ Harbor. NJDEP, Trenton, NJ. June 27, 2007.

Totten, LA. Atmospheric Deposition of PCBs to the NY/NJ Harbor and Delaware River. Plenary Presentation, Hudson-Delaware Chapter, SETAC Annual Meeting, Stockton , NJ. April 27-28, 2007.

Totten, LA. PBDEs in the air and water of the NY/NJ Harbor. Hudson River Foundation. May 3, 2006.

Totten, LA. Invited seminar at City College of New York Chemistry Department. September 26, 2005.

Totten, LA. Sampling for semivolatile organic contaminants in environmental compartments. City College of New York, May 5, 2005.

Totten, LA. Invited seminar, NOAA, Ecosystem Processes Division, Howard Laboratories, Highlands, NJ. October 18, 2004.

Totten, LA, AA Rowe, S Yan. Importance of atmospheric interactions to PCB cycling in the Hudson and Delaware River estuaries. Invited oral presentation, American Chemical Society National Meeting, Philadelphia, August 2004.

Totten, LA, AA Rowe, S Yan, SJ Eisenreich. "Importance of atmospheric interactions to PCB cycling in the Hudson and Delaware River Estuaries." 3rd PCB Workshop on Recent Advances in the Environmental Toxicology and Health Effects of PCBs. Champaign, IL, June 13-15, 2004.

Totten, LA. Invited seminar at Swarthmore College, Swarthmore, PA. April 20, 2004.

Totten, LA. "Present-Day Sources and Sinks for Polychlorinated Biphenyls (PCBs) in the Lower Hudson River Estuary." New York Academy of Sciences, New York City, June 2003.

Totten, LA, CL Gigliotti, DA VanRy, ED Nelson, J Dachs, S Yan, JR Reinfelder, and SJ Eisenreich. "PCBs in the Hudson River Estuary: Atmospheric Inputs and Air-water Exchange." New York Academy of Sciences, New York City, November 2002.

Totten, LA, SJ Eisenreich, PA Brunciak. Evidence for Reactions of PCBs with OH Radical In Urban Atmospheres. 3rd SETAC World Congress, Brighton, United Kingdom, 2000.

Totten, LA, AL Roberts. Alkyl Bromides as Mechanistic Probes of Reductive Dehalogenation: Reactions with Zero-Valent Metals. Graduate Student Paper Award Presentation given at the American Chemical Society Annual Meeting, Boston, MA, August 1998.

Presentations at conferences

Capozzi, SL*; Ran, J; **Rodenburg, LA**; Kjellerup, BV; Wilson, EK. Source apportionment of polychlorinated biphenyls in District of Columbia wastewater. Poster. SETAC 38th Annual Meeting in North America, Minneapolis, MN, November 12-16, 2017.

Rodenburg, LA. Opportunities and Challenges of Environmental Data Mining. Oral Presentation. SETAC 38th Annual Meeting in North America, Minneapolis, MN, November 12-16, 2017.

Chitsaz MM*; **Rodenburg, LA**. PCB cycling in stormwater in an urban high desert: Santa Fe, NM. Poster. SETAC 38th Annual Meeting in North America, Minneapolis, MN, November 12-16, 2017.

Capozzi, SL*; **Rodenburg, LA**; Krumins, V; Fennell, DE; Mack, EE. Using Positive Matrix Factorization to Investigate Microbial Dehalogenation of Contaminants in Groundwater. Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies (Battelle). Miami, FL, May 22-25, 2017.

Capozzi, SL*; Ran, J; **Rodenburg, LA**; Kjellerup, BV; Wilson, EK. Source apportionment of polychlorinated biphenyls in District of Columbia wastewater. Poster presentation at the 2017 Chesapeake Potomac Regional Chapter of the Society of Environmental Toxicology and Chemistry, Annapolis, MD, 2017.

Capozzi, SL*; Ran, J; **Rodenburg, LA**; Kjellerup, BV; Wilson, EK. Source apportionment of polychlorinated biphenyls in District of Columbia wastewater. Oral presentation at the 254th American Chemical Society Fall National Meeting & Exposition, Washington, DC, 2017.

Rodenburg LA, and Du, S*. Data Mining and Source Apportionment to Understand Sources and Fate of PCBs. Poster presentation, 9th International PCB Workshop, October 9-13, 2016 Kobe, Japan.

Rodenburg LA, Capozzi, SL*. Data Mining To Answer Complex Environmental Questions. Platform presentation SETAC 37th Annual Meeting in North America, Orlando, FL, November 6-10, 2016.

Rodenburg, LA; Fahrenfeld, N; Blackburne, B§. Factors controlling antibiotics levels in biosolids. Poster presentation SETAC 37th Annual Meeting in North America, Orlando, FL, November 6-10, 2016.

Blackburne, B; Fahrenfeld, N; **Rodenburg, LA**; Factors controlling antibiotics levels in biosolids. American Chemical Society, 252nd National Meeting, August 21-25, 2016, Philadelphia, PA.

Williams, L; Klein A; Milne M; **Rodenburg L**; Fuchs V; Lindsay R. Analyzing Toxics At Parts Per Quadrillion Levels In The Collection System And Treatment Plant Effluent. WEFTEC 2015, September 26-30, 2015, Chicago, IL.

Uram, A§; Guo, J*; **Rodenburg LA,** Capozzi, SL*. Linking contaminated buildings to atmospheric levels of polychlorinated biphenyls. 8th International PCB Workshop, October 5-9, 2014, Woods Hole, MA.

Capozzi, S*; **Rodenburg, LA**; Guo, J*; Murphy, A§; Fennell, DE. Degradation of PCBs by anaerobic bacteria in sewers. 8th International PCB Workshop, October 5-9, 2014, Woods Hole, MA.

Capozzi, S; **Rodenburg, LA**; Guo, J; Murphy, A; Fennell, DE. Degradation of halogenated pollutants by anaerobic bacteria in sewers. Oral presentation, 2013 North America meeting of the Society for Environmental Toxicology and Chemistry (SETAC). November, 2013.

Rodenburg, LA; Guo, J; Capozzi, S; Murphy, A; Fennell, DE. Degradation of flame retardants by anaerobic bacteria in sewers. Poster presentation, 2013 North America meeting of the Society for Environmental Toxicology and Chemistry (SETAC). November, 2013.

Rodenburg, LA; Guo, J; Praipipat, P; Capozzi, S; Murphy, A; Kraeutler, T. PCBs from pigments in children's clothing, crayons, and paper. Poster presentation, 2013 North America meeting of the Society for Environmental Toxicology and Chemistry (SETAC). November, 2013.

Rodenburg, LA; Guo, J; Praipipat, P. PCBs in pigments, inks, and dyes. Oral presentation at the Hudson-Delaware Chapter of SETAC. May 2, 2013, Edison, NJ.

Rodenburg, LA. PCBs in consumer products, or how to do research with no money. Oral presentation, Department of Environmental Science, Rutgers University. April 12, 2013. New Brunswick, NJ.

Rodenburg, LA; Greenfield, BK; Klosterhaus, SL; Yee, D. Photolytic and microbial debromination of BDEs in San Francisco Bay. Oral presentation at the SETAC North America 33nd Annual Meeting, November 2012, Long Beach, CA.

Rodenburg, LA; Guo, J; Du, S; Fikslin, TJ; Cavallo, GJ. Atmospheric deposition of PCBs to the Delaware River. Oral presentation at the SETAC North America 33nd Annual Meeting, November 2012, Long Beach, CA.

Sandy, AL; **Rodenburg, LA**; Miskewitz, RJ; McGillis, WR; Guo, J. Air-water Exchange Fluxes and Mass Transfer Coefficients for PCBs on the Hudson River. Oral presentation at the SETAC North America 32nd Annual Meeting, November 13-17, 2011, Boston, MA.

Rodenburg, LA; Guo, J; Du, S; Oseagulu, NU; Fennell, DE. Are Dioxins Dechlorinated in Sewers? Oral presentation at the SETAC North America 32nd Annual Meeting, November 13-17, 2011, Boston, MA.

Sandy, AL; **Rodenburg, LA**; Guo, J; Miskewitz, RJ; McGillis, WR. Air-water exchange fluxes and mass transfer coefficients for PCBs on the Hudson River. Oral presentation at the 242nd ACS National Meeting, August 28-September 1, 2011, Denver, CO.

Rodenburg, LA; Du, S; Fennell, DE; Cavallo, GJ. Evidence For Extensive Dechlorination Of PCBs In Sewers, Landfills, And Contaminated Groundwater. Oral presentation at Dioxin 2010, 30th International Symposium on Halogenated Persistent Organic Pollutants (POPs), September 12-17, 2010, San Antonio, TX.

Rodenburg, LA; Du, S; Fennell, DE; Cavallo, GJ. Evidence For Extensive Dechlorination Of PCBs In Sewers, Landfills, And Contaminated Groundwater. Oral presentation, 6th International PCB Workshop, May 20-June 2, 2010, Visby, Sweden.

Sandy, AL; Miskewitz, RJ; **Rodenburg, LA.** Direct Measurement of Air/Water Exchange Mass Transfer Coefficients for Polychlorinated Biphenyls using the Micrometeorological Technique. Poster presentation SETAC 30th Annual Meeting in North America, November 19-23, 2009, New Orleans, LA.

Guo, J; Du, S; **Rodenburg, LA**; Cavallo, GJ. Sources of the non-Aroclor congener PCB 11 (3,3'-dichlorobiphenyl) in urban waterways. Poster presentation SETAC 30th Annual Meeting in North America, November 19-23, 2009, New Orleans, LA.

Guo, J; Du, S; **Rodenburg, LA**; Cavallo, GJ. PCB 11 (3,3'-dichlorobiphenyl) in Urban Waterways From Non-Aroclor Sources. Oral presentation American Chemical Society Northeastern Regional Meeting; October 7, 2009; Hartford, CT.

Park, J-W; Krumins, V; Kjellerup, BV; Gillespie, KM; Fennell, DE; Kerkhof, LJ; **Rodenburg, LA**; Sowers, KR; Häggblom, MM. Anaerobic PCB dechlorination by pentachloronitrobenzene-activated Dehalococcoides spp. American Society for Microbiology 2009 General Meeting; May 17 -21, 2009; Philadelphia, PA.

Krumins, V; Park, J-W; Du, S; **Rodenburg, LA**; Häggblom, MM; Kerhkof, LJ; Fennell DE. Reductive Dechlorination of PCBs in Biostimulated Contaminated Sediment. American Society for Microbiology 2009 General Meeting; May 17 -21, 2009; Philadelphia, PA.

Liu, H; Park, J-W; **Rodenburg, LA**; Fennell, DE; Haggblom, MM. Microbial Community Analysis after Dechlorination Stimulating Treatments of Polychlorinated Dibenzo-p-dioxin and Dibenzofuran Contaminated Sediment. American Society for Microbiology 2009 General Meeting; May 17 -21, 2009; Philadelphia, PA.

Rodenburg, LA; Belton, TJ; Du, S; Sandy, AL; Rowe, AA. Atmospheric deposition, source apportionment, and the TMDL for PCBs in the Delaware River, USA. Oral presentation at the 5th SETAC World Congress, 3 - 7 August 2008, Sydney, Australia.

Rodenburg, LA; Krumins, V; Park, J-W; Haggblom, MM; Kerhkof, LJ; Fennell, DE. Stimulation of PCB Dechlorination and Dechlorinators in Contaminanted Sediments. Oral presentation at the 5th SETAC World Congress, 3 - 7 August 2008, Sydney, Australia.

Asher, BJ; Wong, CS; **Rodenburg, LA**. Chiral signatures as a tool for source apportionment of PCBs in the Hudson River Estuary. Platform presentation SETAC 28th Annual Meeting in North America, November 11-15, 2007, Milwaukee, WI.

Rodenburg, LA. PCB sources and fate in New Jersey. Platform presentation SETAC 28th Annual Meeting in North America, November 11-15, 2007, Milwaukee, WI.

Rodenburg, LA; Zarnadze, A. Water column partitioning of BDEs in the New York/New Jersey Harbor. Platform presentation SETAC 28th Annual Meeting in North America, November 11-15, 2007, Milwaukee, WI.

Asher, BJ; Wong, CS; **Totten, LA**. Chiral signatures as a tool for source apportionment of PCBs in the Hudson River Estuary. Oral presentation, American Chemical Society National Meeting, Boston, MA, August 19-23, 2007.

Fennell, DE; Krumins, V; Ravit, B; **Totten, LA**. Bioremediation approaches for PCB- and PCDD/F-contaminated sediments. Oral presentation, American Chemical Society National Meeting, Boston, MA, August 19-23, 2007.

Du, S.; Xiao, B.; Belton, T.; Fennell, D. E.; **Totten, LA.** Source apportionment of PCBs in the Delaware River and NY/NJ Harbor. Oral presentation, American Chemical Society National Meeting, Boston, MA, August 19-23, 2007.

Sandy, A. L.; Du, S.; Kaczorowski, D. M.; **Totten, LA.** Atmospheric PCB sources to the Delaware River. Oral presentation, American Chemical Society National Meeting, Boston, MA, August 19-23, 2007.

Totten, LA; Du, S; Stenchikov, G. Modeling atmospheric POP dynamics in urban systems. Oral presentation, American Chemical Society National Meeting, Boston, MA, August 19-23, 2007.

Xiao, B.; Du, S.; Fennell, D. E.; Totten, L. A. Source apportionment of POPs in the NY/NJ Harbor. Oral presentation, American Chemical Society National Meeting, Boston, MA, August 19-23, 2007.

Zarnadze, A.; Totten, L. A. Brominated diphenyl ethers in the New York/New Jersey Harbor. Oral presentation, American Chemical Society National Meeting, Boston, MA, August 19-23, 2007.

Kaczorowski, DM; Sandy, AL; Wall, SJ; **Totten, LA**. Investigating the correlation of atmospheric polychlorinated biphenyl concentrations with several variables in Camden, NJ. Poster presented at the Hudson-Delaware Chapter of SETAC Annual Meeting. April 26-27, 2007.

Du, S; **Totten, LA**. Source Apportionment of PCBs in the Delaware River Estuary. Oral presentation at the Hudson-Delaware Chapter of SETAC Annual Meeting. April 26-27, 2007.

Sandy, AL; Du, S; **Totten, LA**. Atmospheric deposition sources of PCBs to the Delaware River. Oral presentation at the Hudson-Delaware Chapter of SETAC Annual Meeting. April 26-27, 2007.

Häggblom, M.M.; Fennell, D.E.; Kerkhof, L.J.; Totten, L.A.; Sowers, K.R.; Ahn, Y.-B.; Liu, F.; Liu, H.; Park, J.-W.; Krumins, V. 2006. Quantifying Enhanced Microbial Dehalogenation of Organohalide Mixtures in Contaminated Sediments. Partners in Environmental Technology Technical Symposium & Workshop sponsored by SERDP and ESTCP. November 28-30, 2006. Washington, D.C.

Pagnout C.; Ní Chadhain, S. M.; **Totten, L. A.**; Zylstra, G. J.; Kukor, J. J. Molecular characterization of microbial community shifts occurring in Passaic River sediments during enrichment on biphenyl and monochlorobiphenyls. 5th Tripartite Workshop in Biotechnology and Bioenergy (NJ, USA), April 2007.

Pagnout, C.; Ní Chadhain, S. M.; **Totten, L. A.**; Zylstra, G. J.; Kukor, J.J. Microbial Diversity Shifts in Sediment Enrichment Cultures during the Aerobic Degradation of Biphenyl and Mono-Chlorinated Biphenyls. American Society for Microbiology, General Meeting, Toronto, Canada, May 21-25, 2007.

Fennell, D.E., Liu, F., Son, E.-K., Zarnadze, A., Krogmann, U., **Totten, L.A.** Fate of Brominated Flame Retardants in New Jersey Wastewater Treatment Facilities. Oral presentation at the USDA NEC 1010 Meeting, Ithaca, NY, October 18-19, 2006.

Zarnadze, A.; **Totten, LA**. BDEs in the New York/New Jersey Harbor, USA. Poster presentation at the SETAC 27th Annual Meeting in North America, 5-9 November 2006, Montreal, Canada.

Du, S; **Totten, LA**. PCB sources to the Delaware River, USA. Oral presentation at the SETAC 27th Annual Meeting in North America, 5-9 November 2006, Montreal, Canada.

Totten, LA; Rowe, AA; Panangadan, M. Atmospheric Deposition and Volatilization of PCBs in the tidal Delaware River. Oral presentation at SETAC 26th Annual Meeting in North America, 13-17 November 2005, Baltimore, Maryland, USA.

Du, S; **Totten, LA**. Attempts to Identify Atmospheric PCB sources in the Philadelphia Metro Area. Oral presentation at SETAC 26th Annual Meeting in North America, 13-17 November 2005, Baltimore, Maryland, USA.

Totten, LA. A Mass Balance On PCBs and PAHs in the NY/NJ Harbor Estuary. Oral presentation at SETAC 26th Annual Meeting in North America, 13-17 November 2005, Baltimore, Maryland, USA.

Fennell, DE; Liu, F; Son, E-K; Zarnadze, A; Krogmann, U; **Totten, LA**. Biotransformation of Halogenated Contaminants in Sludges and Enrichments from Municipal Anaerobic

Digesters. Oral presentation at SETAC 26th Annual Meeting in North America, 13-17 November 2005, Baltimore, Maryland, USA.

Asher, B; Wong, C; **Totten, LA**. Source apportionment of chiral PCBs in the Hudson River Estuary. Poster presentation at SETAC 26th Annual Meeting in North America, 13-17 November 2005, Baltimore, Maryland, USA.

Totten, LA; Du, S. Atmospheric PCB Sources in the Philadelphia Metro Area. SETAC Hudson-Delaware Chapter Regional Meeting, April 28, 2005.

Du, S; **Totten, LA** Identifying source areas of PCBs to the Camden/Philadelphia atmosphere. Poster presentation, SETAC 25th Annual Meeting, Portland, OR, November 14-18, 2004.

Rowe, AA; **Totten, LA**; Offenberg, JH; Reinfelder, JR; Eisenreich, SJ. Air-water exchange of polychlorinated biphenyls in the Delaware River Basin. Poster presentation, SETAC 25th Annual Meeting, Portland, OR, November 14-18, 2004.

Rowe, AA; **Totten, LA**; Offenberg, JH; Sommerfield, CK; Du, S; Reinfelder, JR; Eisenreich, SJ. Accumulation of PCBs in sediments of the Delaware River Estuary. Poster presentation, SETAC 25th Annual Meeting, Portland, OR, November 14-18, 2004.

Wall, SJ; **Totten, LA**. A Mobile Platform for Air Toxics Monitoring in New Jersey, USA. Poster presentation, SETAC 25th Annual Meeting, Portland, OR, November 14-18, 2004.

Zarnadze, A; **Totten, LA**; Eisenreich, SJ. Measurements of Polybrominated Diphenyl Ethers (PBDEs) in the air and water of NY/NJ Harbor Estuary. Poster presentation, SETAC 25th Annual Meeting, Portland, OR, November 14-18, 2004.

Totten, LA. Importance of atmospheric interactions to PCB cycling in the Hudson and Delaware River Estuaries. Poster presentation, SETAC 25th Annual Meeting, Portland, OR, November 14-18, 2004.

Totten, LA; Litten, SP. Mass Balance On PCBs and PAHs in the NY/NJ Harbor Estuary. Poster presentation, SETAC 25th Annual Meeting, Portland, OR, November 14-18, 2004.

Zarnadze, A, **LA Totten**. Levels of Polybrominated Diphenyl Ethers (PBDEs) in the Atmosphere of New Jersey, USA. Oral Presentation, Dioxin 2004, Berlin, Germany, September 2004.

Polidori, A, BJ Turpin, HJ Lim, **LA Totten**, C Davidson. Characterization Of The Organic Fraction Of Atmospheric Aerosols. Annual Meeting of the American Association for Aerosol Research, Atlanta, GA, October 2004.

Totten, LA, S Litten. Mass Balances On PCBs and PAHs in the NY/NJ Harbor Estuary. Oral presentation at the 36th Mid-Atlantic Industrial and Hazardous Waste Conference, University of Connecticut, Storrs, CT, October 8-10, 2004.

Zarnadze, A, **LA Totten**, DE Fennell, MP Giacalone, U Krogmann. PBDEs in the NY/NJ Harbor estuary. Poster presentation, American Chemical Society National Meeting, Philadelphia, August 2004.

Rowe, AA, S Du, SJ Eisenreich, JH Offenberg, **LA Totten**, A Zarnadze. Accumulation of PCBs in sediments of the Delaware River Estuary. Oral presentation, American Chemical Society National Meeting, Philadelphia, August 2004.

Rowe, AA.; Eisenreich, SJ.; Offenberg, JH.; **Totten, LA**. "Accumulation of PCBs in sediments of the Delaware River Estuary." Oral Presentation, Society of Toxicology and Chemistry 24th Annual Meeting in North America, Austin, Texas, November **2003**.

Yan, S, **LA Totten**, CL Gigliotti, JH Offenberg, SJ Eisenreich, J Dachs, JR Reinfelder. "Air-water exchange controls phytoplankton PCB concentrations in impacted estuaries."

Society of Toxicology and Chemistry 24th Annual Meeting in North America, Austin, Texas, November **2003**.

Zhuang, Y, KM Ellickson, SJ Eisenreich, **LA Totten**, JR Reinfelder. "Atmospheric deposition and impacts of trace metals and mercury in the New Jersey Atmospheric Deposition Network (NJADN)." Poster, Society of Toxicology and Chemistry 24th Annual Meeting in North America, Austin, Texas, November **2003**.

Zarnadze, A, **LA Totten,** JH Offenberg, CL Gigliotti, SJ Eisenreich. "Measurements of Poly-brominated Diphenyl Ethers (PBDE) in the air and water of Hudson River Estuary." Poster, Society of Toxicology and Chemistry 24th Annual Meeting in North America, Austin, Texas, November **2003**.

Ellickson, KM, Y Zhuang, BJ Turpin, SJ Eisenreich, **LA Totten**, JR Reinfelder. "Source identification of mercury and other trace metals in New Jersey fine particulate matter (PM2.5) and rain." Poster, Society of Toxicology and Chemistry 24th Annual Meeting in North America, Austin, Texas, November **2003**.

Cardona-Marek, T, KM Ellickson, **LA Totten**, JR Reinfelder. "Mercury Cycling in the Estuarine Zones of the Delaware River." Poster, Society of Toxicology and Chemistry 24th Annual Meeting in North America, Austin, Texas, November **2003**.

Totten, LA, JR Reinfelder, CL Gigliotti, DA Van Ry, J Dachs, JH Offenberg, Y Koelliker, M Panangadan, S Yan, Y Zhuang, SM Goodrow, KM Ellickson, R Gioia, and SJ Eisenreich. "Atmospheric Deposition of Organic and Inorganic Contaminants to the New Jersey Meadowlands." Oral presentation, Meadowlands Symposium, New Jersey Meadowlands Commission, Lyndhurst, NJ, October 9 and 10, **2003**.

Totten, LA, S Yan, and CL Gigliotti. "PCBs: The Lower Hudson River Estuary and the New Jersey Atmospheric Deposition Network." Oral presentation, American Chemical Society National Meeting, New York City, September 2003.

Assaf-Anid, NM, M Blenner, **LA Totten**, Y-B Ahn, DE Fennell, and M Haggblom. "Agreement of computational chemistry predictions of reductive dechlorination pathways with experimental microcosm studies." Poster, American Chemical Society National Meeting, New York City, September 2003.

Rowe, AA, SJ Eisenreich, CL Gigliotti, JH Offenberg, and **LA Totten**. "Interactions of atmospheric polychlorinated biphenyls with the Delaware River Estuary." Oral presentation, American Chemical Society National Meeting, New York City, **2003**.

Gigliotti, CL. **LA Totten**, DA VanRy, PA Brunciak, TR Glenn, J Dachs, SJ Eisenreich. "Atmospheric Deposition and Air-Water Exchange of PAHs in the NY/NJ Harbor Estuary." Oral presentation, Society of Environmental Toxicology and Chemistry, 22nd Annual Meeting, Baltimore, Maryland, **2001**.

Totten, LA, CL Gigliotti, DA VanRy, TR Glenn, SJ Eisenreich. "Atmospheric Deposition and Air-water Exchange of Heptachlor in the NY/NJ Harbor Estuary." Oral presentation, Society of Environmental Toxicology and Chemistry, 22nd Annual Meeting, Baltimore, Maryland, **2001**.

Totten, LA, X Liu,DJ Braun, Assaf-Anid, NM. "Use Of Computational Chemistry To Predict Reduction Potentials Of Polychlorinated Biphenyls." Poster, American Chemical Society Annual Meeting, San Diego, CA, April **2001**.

Assaf-Anid, N. Robert Ambrosini, Xuefeng Liu, Lisa Totten. "A Comparison of Computational Chemistry and Bond Contribution Calculations as Tools for Two-electron Redox

Determinations of PCBs." Poster, Society of Environmental Toxicology and Chemistry, 22nd Annual Meeting, Baltimore, Maryland, **2001**.

Totten, LA, CL Gigliotti, DA VanRy, PA Brunciak, TR Glenn, SJ Eisenreich. Atmospheric Deposition and Air-Water Exchange of PCBs in the NY/NJ Harbor Estuary. Poster, Society of Environmental Toxicology and Chemistry, 22nd Annual Meeting, Baltimore, Maryland, **2001**.

Totten, LA, X Liu, DJ Braun, NM Assaf-Anid. "Use Of Computational Chemistry To Predict Reduction Potentials Of Polychlorinated Biphenyls." Poster, American Chemical Society Annual Meeting, San Diego, CA, April **2001**.

Van Ry, DA, TR Glenn, C Schauffele, R Gioia, CL Gigliotti, **LA Totten**, SJ Eisenreich. "Atmospheric PCBs and PAHs from an Urban to a Forested Area in the Mid-Atlantic States." Oral presentation, Society of Environmental Toxicology and Chemistry, 22nd Annual Meeting, Baltimore, Maryland, **2001**.

Assaf-Anid, NM, **LA Totten**, SJ Braun. "Computational chemistry calculations of thermodynamic descriptors for chlorinated aliphatic compounds and PCBs." Poster, Society of Environmental Toxicology and Chemistry National Meeting, Nashville , TN, **2000.**

Braun, DJ, NM Assaf-Anid, **LA Totten**, "Computational Chemistry: A Novel Approach for Redox Potential Calculations." Oral Presentation, The 32nd Annual Mid-Atlantic Industrial and Hazardous Waste Conference, Rensselaer Polytechnic Institute, **2000**.

Cummings, DA, **LA Totten**, T Lectka, AL Roberts. "Computational Methods For Predicting Heats Of Formation Of Halogenated Methyl And Ethyl Radicals." Oral presentation, American Chemical Society Annual Meeting, Anaheim, CA, April **2000**.

Totten, LA, AL Roberts. "Kinetics of inner-sphere reduction reactions of polyhalogenated methanes." Poster, American Chemical Society Annual Meeting, San Francisco, CA, **1997**.

Totten, LA, AL Roberts. "Stereospecificity of vicinal dehalogenation reactions promoted by abiotic reductants." Poster, Environmental Sciences: Water Gordon Research Conference, New Hampton, NH, June **1996**.

Roberts, AL, DR Burris, TJ Campbell, JA Specht, WA Arnold, **LA Totten**. "Influence of electron transfer pathway on products resulting from metal-promoted reduction of chlorinated ethenes." Oral presentation, IBC International Symposium on Biological Dehalogenation, Annapolis, MD, October 18-19, **1995**.

Totten, LA, AL Roberts. "Investigating electron transfer pathways during reductive dehalogenation reactions promoted by zero-valent metals." Oral presentation, American Chemical Society Annual Meeting, Anaheim, CA, April **1995**.

PAST AND CURRENT SUPPORT

NY/NJ Harbor Contamination Assessment and Reduction Project: CARP II. NJDOT. 7/1/2016-6/30-2018. LA Rodenburg and RJ Miskewitz. Subcontract to Rutgers: $190,000. Full grant: $4,000,000 to Monmouth U.

Rutgers University Raritan River Initiative. EPA. 7/1/2012-6/30/2015. CC Obropta, B Ravit, LA Rodenburg. $100,000

Using Sewage to Treat Contaminated Sediment. Rutgers Office of Technology Commercialization. 9/1/2012-8/30/2014. LA Rodenburg, RJ Miskewitz. $50,000.
Where is microbial dehalogenation occurring in the groundwater at Chambers Works? DuPont Corporation. 1/1/2012-12/31/2014. LA Rodenburg, V Krumins. $300,000.
Baseline Assessment of Water and Sediment Quality in the Lower Raritan River. Edison Wetlands Association. 1/1/2011 – 12/31/2012. LA Rodenburg, LJ Kerkhof. $50,000.
Talking Creativity: Conversations between Scientists and Artists. RU FAIR mini-grant proposal. 1/1/2011-6/30/2011. F Olin, LA Rodenburg. $4400.
Continuation of the New Jersey Atmospheric Deposition Network (NJADN). Delaware River Basin Commission. 1/1/2010-6/30/2012. Approx. $100,000 per year. LA Rodenburg.
Quantifying Enhanced Microbial Dehalogenation Impacting the Fate and Transport of Organohalide Mixtures in Contaminated Sediments. SERDP. 3/1/2006-2/28/2010. $1,880,000. MM Haggbloom, DE Fennell, LA Totten, LJ Kerkhof, and K Sowers (UMd).
Measuring Indoor Air Quality in "Green" Hotel Rooms. Hartz Mountain Industries. 1/2009-6/2009. $10,000. LA Rodenburg and J Senick (RU Center for Green Building).
A Gas Chromatograph-Mass Spectrometer (GCMS) for the Analysis of Organic Compounds in Marine and Environmental Samples. Cook/NJAES Intramural Awards Program, Research Infrastructure Awards. 3/10/09-6/30/09. $25,500 EL Sikes, P Falkowski, DE Fennell, W Huang, LA Rodenburg and N Yee.
Measuring Indoor Air Quality in "Green" vs. Conventional Residential Construction. BASF Corporation. 9/2008-3/2009. $3,000. LA Rodenburg and J Senick (RU Center for Green Building).
Graduate student fellowship to Andy L. Sandy. Hudson River Foundation. 9/1/08-8/31/09. $16,000. AL Sandy and LA Rodenburg.
Assessing the Status of Women in Engineering at Rutgers University. Office of the Associate VP for Promotion of Women in Science, Engineering and Mathematics, Rutgers University. 7/1/2008-3/31/2009. $7,950. M Baykal-Gursoy, J Bennett, HM Buettner, L Klein, U Krogmann, M Pelegri, LA Rodenburg, PA Roos.
Volatilization of PCBs from the Tappan Zee region of the Hudson River. NJWRRI. 3/1/2008-2/28/2009. $30,000. LA Rodenburg and RJ Miskewitz.
Continued Air Monitoring for PCBs in the Delaware River Estuary via the NJADN. Delaware River Basin Commission. 6/1/08-12/31/09. $70,000. LA Rodenburg
Passive Air Sampling for PCBs in the Philadelphia Area. Delaware River Basin Commission. 10/1/06-12/31/07. $24,000. LA Totten
Continued Air Monitoring for PCBs in the Delaware River Estuary via the NJADN. Delaware River Basin Commission. 10/1/06-12/31/07. $88,000. LA Totten
Insights into the Cycling of PCBs in the NY/NJ Harbor Estuary from Chiral Analysis. NJDEP. 7/1/2006-6/30/2007. $50,000. LA Totten.
Construction of a Flux Chamber to Determine Air–Water Exchange Mass Transfer Coefficients of Hydrophobic Organic Contaminants. Cook/NJAES Intramural Awards Program, Pre-Tenure Faculty Career Development Awards. 3/10/06-6/30/06. $29,540. LA Totten.
An Accelerated Solvent Extraction (ASE) System for Analysis of Anthropogenic and Natural Chemicals in Environmental Samples and Biota. Cook/NJAES Intramural Awards Program, Research Infrastructure Awards. 3/10/06-6/30/06. $34,620. LA Totten, DE Fennell, MM Haggblom, W Huang, L Kerkhof, C Obropta, EL Sikes, LA White.

Source apportionment of organic contaminants in the NY/NJ Harbor Estuary. Hudson River Foundation. 7/1/2005-12/31/2007. $95,300. LA Totten and DE Fennell.
Source Apportionment of PCBs in the Delaware River Estuary. NJDEP. 7/1/2005-6/30/2006. $65,000. LA Totten.
Impacts of Organic Matter Heterogeneity on Desorption and Availability of Sediment-Bound PCBs. NJWRRI. 3/1/2005-2/28/2006. $30,000. W Huang and LA Totten.
Triple Quadrupole GC/MS For Analysis of Trace Organics in Environmental Matrixes. (Instrumentation Grant). Academic Excellence Fund, Rutgers University. 2004-2005. $175,000. LA Totten, DE Fennell, JR Reinfelder, W Huang, BJ Turpin, RM Sherrell, EL Sikes, LA White.
Graduate Student Fellowship to Archil Zarnadze. Hudson River Foundation. 9/1/04-8/31/05. $16,000. A Zarnadze and LA Totten.
Fate of Brominated Flame Retardants in New Jersey Wastewater Treatment Facilities. NJWRRI. 3/1/2004-2/28/2005. $30,000. DE Fennell, LA Totten and U Krogmann.
Continued Measurement and Modeling of Atmospheric PCBs in the Delaware River Basin. Delaware River Basin Commission, $95,000, 2003-2005
Community Based Air Toxics Monitoring Studies. NJDEP, $272,000, 1/1/2003-12/31/2004. LA Totten.
Emissions And Atmospheric Transport Of PCBs And Hg From Stabilized Harbor Sediments. NJ Marine Sciences Consortium, $219,000, 4/3/2003-6/60/2004. JR Reinfelder, LA Totten, G Stenchikov, GP Korfiatis, RI Hires.
Measurement of Atmospheric PCBs in the Delaware River Basin. Delaware River Basin Commission, $316,000, 2001-2005. LA Totten, JR Reinfelder, SJ Eisenreich.
Measurement of PBDEs in the Air and Water of the Hudson River Estuary. Hudson River Foundation, $176,000, 7/1/2002-6/30/2004. LA Totten, SJ Eisenreich.
Characterizing Organic Fine Particulate Matter (PM2.5) for the Pittsburgh Supersite. Electric Power Research Institute, $50,000, 2002. BJ Turpin, LA Totten.
Atmospheric Dry Particle Deposition of POPs and Trace Metals in an Urban- and Industrially-Impacted Mid-Atlantic Estuary. US EPA, $230,000, 2000-2004. LA Totten, SJ Eisenreich, T Holsen.

Consulting projects

Baron and Budd Law Firm (2017-present): Expert witness in various lawsuits including City of Spokane and State of Washington versus Monsanto.
Washington State Department of Ecology and EPA under subcontract to Leidos (2016): Evaluate And Conduct Factor Analysis On PCB Data From The Green/Duwamish River
County of Spokane, WA under subcontract to Brown and Caldwell (2014): Source apportionment of PCBs and BDEs in the wastewater of Spokane.
New York Academy of Science (2010): Evaluation of on-going sources of organic contaminants to the lower Passaic River.

New York Academy of Science (2005): Mass balance on PAHs in the New York/New Jersey Harbor
New York Academy of Science (2004): Mass balance on PCBs in the New York/New Jersey Harbor

STUDENT ADVISING
PhD students (primary advisor):
Amy A. Rowe, PhD completed 2006. Interactions Of Polychlorinated Biphenyls With The Air, Water, And Sediments Of The Delaware River Estuary. Amy is tenured as the Cooperative Extension Agent in Passaic County for the Rutgers New Jersey Agricultural Experiment Station.
Songyan Du, PhD completed 2008. Source Apportionment and Measurement of PCBs and POPs in NY/NJ Area. Songyan works for the NJ Department of Health measuring PCBs in human blood and other samples.
Archil Zarnadze, PhD completed 2010. Poly-Brominated Diphenyl Ethers (PBDEs) in the Air and Water of the NY/NJ Harbor and in the Air of Philadelphia/Camden Area.
Andy L. Sandy, PhD completed 2010. The Application of a Micrometeorological Technique to Measure Air-Water Exchange of Polychlorinated Biphenyls.
Jia Guo, PhD completed 2013. Fate and Transport of Polychlorinated Biphenyls in the Air, Water, and Sewers of the Delaware River Basin.
Pornsawai Praipipat, PhD 2014. Source Apportionment of Polychlorinated Biphenyls in New Jersey air and Delaware River sediments.
Staci L. Capozzi, PhD completed 2016. Using Positive Matrix Factorization to Investigate Microbial Dechlorination of Contaminants in Groundwater.

MS students (primary advisor):
Dawn Cacia, MS completed 2010. Statistical Analysis of Atmospheric Polychlorinated Biphenyl Concentrations at Two Urban Locations.
Gerald Rustic, MS completed 2011. PAH contamination in the sediments of the Arthur Kill.
Yashika Dewani, MS completed 2016. Dechlorination of Polychlorinated Dibenzo-p-Dioxins in the Watershed of The New York/New Jersey Harbor.

Non-thesis MS students (primary advisor):
Maya Panangadan (MS completed 2004)
Steven J. Wall (MS completed 2006)
Hye-Nah Yoo (MS completed 2015)
Nicholas Morgan (MS completed 2015)

Thesis/Dissertation committees:
Dana Armstrong (PhD expected 2018 in Civil and Environmental Engineering, UMd College Park)
Kelly Francisco (PhD 2016)
Hang Dam (PhD 2016)
Lauren Weisel (MS Marine Science, 2015)

Rouzbeh Tehrani (PhD in Civil and Environmental Engineering 2013, Temple University)
Nathan Howell (PhD in Civil and Environmental Engineering 2012, University of Houston)
Il Kim (PhD 2009)
Derek Wright (PhD 2008)
Lora Smith (PhD 2008)
Samriti Sharma (PhD 2007)
Andrea Polidori (PhD 2005)
Sathyapriya Thota (MS in Civil and Environmental Engineering 2004)
Yan Zhuang (PhD 2004)
Dan Salvito (PhD 2003)
Rosalinda Gioia (MS 2003)
Shu Yan (MS 2003)
Cheng-Wei Fan (PhD 2002)

Undergraduate interns (partial list)
GHC = George H. Cook Honors Thesis
ISR = Intro to Scientific Research course part of the Douglass Project for Women in STEM

Ady Miretsky
Alden Adrion
Alex Anderson (ISR)
Alexis Uram (ISR)
Anthony Murphy (ARESTY and GHC)
Anthony DeCristofano
Anton Woronczuk (ARESTY)
Ashtyn Greenstein (ISR)
Athina Ramadanis
Brittney Blackburne (ISR and GHC)
Chris Schauffele
Daniel Frier
Dawn Cacia
Erin Mayfield
Farah Mahmud
Harini Sadeeshkumar
Huibin Luo (GHC)
Hye Na Yoo
John Lisowski (ARESTY)
Kerry Jade Manzano
Lea Perez (GHC)
Masrur Alam
Matt Columbo
Mindaugus Rimkus
Nicole Oseagulu
Rebekka Reider
Robert Pawle
Sabah Mahmud
Shiqi Wu
Steve Wall
Zachary Bakhtin

High school students (science fair projects and other research):
Thomas Kreisel – triclosan in drinking water – Thomas won the New Jersey Stockholm Junior Water Prize for this research.
William Zupko – trace metals in sediment samples from Woodbridge Creek
Bryan Schwab - brominated flame retardants in indoor and outdoor air
Sarah Tanner – source apportionment of PCBs in the sediment of the NY/NJ Harbor
Mitchell Booth – VOCs emitted from crumb rubber mulch (Liberty Science Center Partners in Science program)
Rachel Ruben – designing a drinking water treatment system for developing countries
Andrew Baskharon – phytoremediation of malathion
Mikel Byers (Nixon-Smiley High School, Nixon, TX) – water quality impacts of hydraulic fracturing
Ricardo Rivera – Biodegradation of BDEs (Liberty Science Center Partners in Science program) 2014

Kartik Bhardwaj – Source apportionment of PCBs in San Francisco Bay (Liberty Science Center Partners in Science program) 2015

Nishita Sinha – migration of fecal coliform out of a novel sand pit toilet in India 2015. This research has earned multiple awards:

- Recipient of the National Stockholm Junior Water Prize (after winning the State competition). The award includes $10,000 and an all-expenses paid trip to the World competition in Stockholm, Sweden.
- Ms. Sinha was selected for the 2016 MIT summer Research Science Academy, a highly selective program
- Arizona State University Walton Sustainability Award
- Theobald Smith Society Award in Microbiology
- National Oceanic and Atmospheric Administration (NOAA) Pulse of the Planet Award
- NJ Water Environment Association Award
- International Sustainable World (Energy, Engineering, and Environment) Project (ISWEEEP) Sustainable World Award
- Honorable mention at the International Sustainable World (Energy, Engineering, and Environment) Project Olympiad in Houston, Texas
- Fourth Place Oral Presenter at the regional Junior Sciences and Humanities Symposium at Rutgers (JSHS)

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF WASHINGTON

CITY OF SPOKANE, a municipal corporation located in the County of Spokane, State of Washington,	)	Case No. 2:15-cv-00201-SMJ
Plaintiff,	)	
-vs-	)	
MONSANTO COMPANY, et al.,	)	
Defendants.	)	

SHOOK HARDY & BACON
2001 MARKET STREET - SUITE 3000
PHILADELPHIA, PENNSYLVANIA 19103
DECEMBER 18, 2019
10:14 A.M.

VIDEOTAPED DEPOSITION OF
LISA A. RODENBURG, PH.D.

REPORTED BY:
DEBRA SAPIO LYONS, RDR, CRR, CRC, CCR, CLR, CPE
JOB NO. 173395

Lisa A. Rodenburg, Ph.D.

to ask you all the same questions that I asked you in those depositions or can we assume that they accurately reflect the opinions that you hold in this case?

MR. LAND: Objection, vague.

MR. GOUTMAN: Okay. Let me -- let me be more specific.

BY MR. GOUTMAN:

Q. I asked you a series of questions concerning the identity of congeners that have been described as byproduct PCBs.

Have your opinions changed on that since June of 2019, several months ago, since we last took your deposition?

A. No.

Q. Same question with respect to the concentration of those congeners.

MR. LAND: Objection, vague. Concentration in general products, in stormwater?

BY MR. GOUTMAN:

Q. The questions that I asked concerning the reported concentrations of byproduct congeners in pigments in particular,

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has your -- have your opinions changed since June?

A. No, not that I know of.

Q. Okay. The types of products in which byproduct PCBs are found, have your opinions changed?

A. No.

Q. The ubiquity of byproduct PCBs in the environment, have your opinions changed?

A. No.

Q. The lack of enforcement as described in your last deposition by the EPA of the 50 ppm standard with respect to byproduct PCBs?

A. As described in my deposition, I answered that question truthfully and my opinion has not changed.

Q. Okay. The fact that the -- over the past couple decades virtually all of the pigments are being imported from China and India, your opinions haven't changed concerning that; correct?

A. As far as --

MR. LAND: Objection, assumes facts

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and vague.

Go ahead.

THE WITNESS: As far as I know, no, my opinions have not changed.

BY MR. GOUTMAN:

Q. Yeah. And, in fact, you've written on that; correct?

A. Yes, and I haven't written anything since that last deposition, so there would be no -- nothing new to contradict what I said in the deposition.

Q. The fact that by -- we asked you questions concerning the fact that byproduct PCBs have been detected in numerous bodies of water, which by themselves exceed the Federal Water Quality Standard, your opinions haven't changed with respect to those questions that we asked you?

A. Correct.

MR. GOUTMAN: There, we accomplished something.

MR. LAND: All right.

MR. GOUTMAN: This will dispense with about 20 pages of questions.

in a sample.

BY MR. GOUTMAN:

Q. So your answer is yes?

A. Yes.

Q. In addition, of course, there are other manufacturing processes that produce byproduct PCBs. You're aware of that; right?

A. Yes.

Q. And the EPA in 1983, when they passed regulations on this, listed some 200 manufacturing processes that could potentially create byproduct PCBs. You're aware of that?

A. Yes.

Q. And that list was collected in a paper that Mr. Coghlan, one of Plaintiff's experts, was brought to our attention, which I'm about to show you.

A. Okay.

MR. GOUTMAN: We'll mark this as Exhibit 9.

(Exhibit Rodenburg-9, multipage document entitled Pollution Prevention and Management Strategies for Polychlorinated Biphenyls in the New York/New Jersey

River watershed; correct?

A. That is correct.

Q. Would you agree that combustion reactions can create PCBs?

A. Yes.

MR. GOUTMAN: Why don't we go to Ishikawa. Just give me all of those.

(Exhibit Rodenburg-10, multipage document entitled PCB decomposition and formation in thermal treatment of plant equipment, is marked for identification.)

BY MR. GOUTMAN:

Q. We've marked as Exhibit 10 a paper by Ishikawa, et al. called, "PCB decomposition and formation in thermal treatment of plant equipment."

Are you familiar with this paper?

A. It's not ringing a bell, no.

Q. Okay. What this papers shows, and you can take a second and read it, I'm just going to direct your attention to a few passages, but they basically -- excuse me for coughing -- they basically ran combustion experiments, just looking at the top of the

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BY MR. GOUTMAN:

Q. Why don't we go back to this paper by Ishikawa. It says, "PCB concentration" -- this is the second paragraph, the conclusion. "PCB concentration and the number of congeners increased at the kiln exit. While this behavior was common to RDF and ASR, the increase in PCB concentration at the kiln exit was greater with the combustion of ASR than KDF."

So what they're saying there is that different types of refuse produce different types of PCBs or different amounts of PCBs; correct?

A. Yes, that's what they're saying.

Q. And they say later that it produced different types of PCBs; correct?

A. That -- yes, that is what it says.

Q. It says a couple sentences down, [as read]: "And, the predominate homologues were higher PCBs such as hepta-C -- CB and deca-CB with the combustion of ASR, while the lower chlorinated PCBs, such as DiPCB and penta-PCB were with the combustion of RDF";

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right?

A. That's what it says, yes.

Q. So here they're saying that it was producing PCBs with different degrees of chlorination depending upon the kind of refuse that was being incinerated; correct?

A. That's what it's saying, yes.

Q. And they give, in fact, later identify specific congeners. Going to the first full paragraph on the right column, a few lines down, [as read]: "The combustion marker congeners for RDF were numbers 13/12, 35, 77, 126, while those for ASR were 170, 189, 194, 195, 196, 206, and 209. In combustion of RDF, non-ortho-PCB were predominantly formed, whereas ortho-PCB or symmetric chlorine substituted by PCB were destroyed. Higher chlorinated PCB were more readily formed by combustion of ASR than RDF. The high-chlorination might be caused -- might be cause the amount of more chlorine in ASR than RDF."

Did I read that correctly?

A. Yes.

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Q. So that just, again, confirms what you and I discuss, which is what they're finding is that in the active thermal treatment or incineration, some PCBs are being destroyed and others are being created de novo; correct?

A. I don't know about de novo, but -- but, yes, that's basically what they're saying.

Q. Well, they're saying that they were readily formed; correct?

A. Well, to me de novo means formed from chlorine and carbon whereas they could have been formed by dechlorination of other congeners, which, to me, is not de novo synthesis. But this is just splitting hairs.

(Exhibit Rodenburg-11, multipage document entitled Effects of oxygen, catalyst and PVC on the formation of PCDDs, PCDFs and dioxin-like PCBs in pyrolysis products of automobile residues, is marked for identification.)

BY MR. GOUTMAN:

Q. We've marked as Exhibit 11 a paper

by -- I don't know how to pronounce the name -- Joung, J-O-U-N-G, et al., called "Effects of oxygen, catalyst and PV -- PVC on the formation of PCDDs, PCDFs and dioxin-like PCBs in pyrolysis products of automobile residues"; is that correct?

A. Correct.

Q. And what they find is that -- well, let's go to the conclusions.

The -- I'm just going to focus on the fourth bullet down.

A. Uh-huh.

Q. It says, "Through the relationship between the presence" -- excuse me.

[As read]: "Though the relationship between the presence of P -- P -- PVC and the formation of dioxins was not clear, it was confirmed that dioxin-like PCBs were generated during the pyrolysis reactions with P -- PVC present. Without PVC as a source of chlorine, dioxin-like PCBs were not found in pyrolysis byproducts even with and without the presence of a catalyst and oxygen."

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Did I read that correctly?

A. Yes.

Q. So what they're finding is that when they are burning refuse with PVC in it, they are creating dioxin-like PCBs; right?

MR. LAND: And take your time to read through the document if you need to to confirm that.

THE WITNESS: (Reviewing document.)

Yeah, I mean they say that dioxin-like PCBs were generated during pyrolysis.

(Reporter clarification.)

THE WITNESS: Sorry. Sorry. Sorry.

They -- they do say that dioxin-like PCBs were generated during pyrolysis reactions with PVC present, so that is what they concluded. Again, I haven't read the paper carefully, so I don't know if I agree with those conclusions, but that's what they concluded.

MR. LAND: Whenever you read, read slow --

THE WITNESS: Yeah, sorry.

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MR. LAND: -- that way she can take it.

THE WITNESS: I tend to talk fast. Sorry.

MR. GOUTMAN: Why don't we mark as Exhibit 12...

(Exhibit Rodenburg-12, multipage document entitled Formation of PCDDs, PCDFs, and Coplanar PCBs from Incineration of Various Woods in the Presence of Chlorides, is marked for identification.)

MR. GOUTMAN: Ready?

BY MR. GOUTMAN:

Q. Marked as Exhibit 12 a paper by Yasuhara, Y-A-S-U-H-A-R-A, titled, "Formation of PCDDs, PCDFs, and Coplanar PCBs from Incineration of Various Woods in the Presence of Chlorides."

Did I read that correctly?

A. Correct.

Q. Are you familiar with this paper?

A. Again, not ringing a bell. I may have read it, but if so, I don't remember it.

Q. But it just -- I just want to

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direct your attention to the right column halfway down the first paragraph there, "Therefore, there are many reports on the formation of dioxins and dioxin-like compounds from various woods upon combustion."

And you're familiar with that literature, the burning of wood can create dioxin and dioxin-like compounds --

A. Yes.

Q. -- is that correct?

A. Yes.

Q. And dioxin-like compounds would include dioxin-like PCBs; correct?

A. Usually, yes.

Q. And if you turn to Table 3, which is on -- couple pages in, it does note analytical results from exhaust gases from combustion of samples. And on the bottom it does indicate the formation of what they call coplanar PCBs; correct?

A. Correct.

Q. And those are dioxin-like PCBs; right?

A. I believe so, yeah.

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MR. GOUTMAN: Sure.

THE VIDEOGRAPHER: We are going off the record at 11:13.

(A recess is held from 11:14 a.m. to 11:24 a.m.)

(Exhibit Rodenburg-14, multipage document entitled Special Guides Green Issue April 21, 2016 To Burn or Bury?, is marked for identification.)

THE VIDEOGRAPHER: We are back on record at 11:25.

BY MR. GOUTMAN:

Q. I've marked as Exhibit 14 an article on the City of Spokane Waste-to-Energy Plant.

Can you take a look at that?

A. Okay.

Q. I don't think it's necessary for you to read the whole article. I just am using this to confirm that, in fact, the City of Spokane does have a waste-to-energy plant incinerator?

A. That is correct. That's what it says.

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Q. And it says, "Last year, Spokane's Waste-to-Energy plant took in around 138,000 metric tons of garbage that would have otherwise been dumped in a landfill"; correct?

A. That's what it says, yes.

Q. And it says if you turn to one, two, three -- four -- the fourth page, this one (indicating) above the -- two paragraphs -- three paragraphs above "The Clean Air Rule," "While there are some harmful gases - like dioxins and furans - released at the Spokane plant that have been -- have environmental groups concerned, currently Spokane's levels fall far below the federal limit."

Do you know whether they have tested the gases for PCBs?

A. I don't know.

Q. Do you think they should?

MR. LAND: Objection, misleading, vague, incomplete hypothetical.

THE WITNESS: I have no idea.

(Counsel confer.)

BY MR. GOUTMAN:

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Q. -- if you can, read from Line 16 down to Page 53, Line 10. Read it aloud for the record.

MR. LAND: And slowly.

THE WITNESS: Was I slow enough last time?

"And so this is a problem for the City of Spokane, or the County of Spokane, because they can" --

BY MR. GOUTMAN:

Q. I'm sorry. Let me interrupt. Start from Line 13.

A. 13.

Q. The entire paragraph.

A. Oh, sure.

"And the one PCB congener that is now dominant in the effluent is PCB-11, which is the one that comes from pigments. And so this is a problem for the City of Spokane, or the County of Spokane, because they can go after the Aroclor-type sources. They're one of the cities suing Monsanto, for example. They can try to remove all transformers and capacitors. You know, they can try to do a

lot of things to remove the Aroclor-type PCBs from their system, but that's not their main problem. Their main problem is PCB-11 for pigments; and what are they going to do about that. That's quite difficult, because people are always going to use color-printed, you know, paper; and they're always going to wear printed clothing. And they're always going to have these PCB -- these pigments in their system. There's not much that Spokane County can do about their worst PCB problem."

Q. So when you gave this webinar -- by the way, what was the purpose of this webinar and what was the audience?

A. It was a continuing education project run by Rutgers.

Q. Okay. So you were there as an educator?

A. Yes.

Q. And when you lecture as an educator, you attempt to give accurate information; correct?

A. Yes.

Q. At -- as of September 25, 2017,

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A. Correct.

Q. And you say Aroclors. By that do you mean commercially produced PCBs as opposed to just Monsanto's Aroclors?

A. By Aroclors I mean things that matched the Aroclor fingerprints that I had.

Q. And we discussed at the last deposition the fact that PCBs were made by numerous manufacturers for decades all around the world; correct?

A. Correct.

Q. Other than Monsanto; correct?

A. Correct.

Q. And you haven't reviewed Mr. Coghlan's deposition, but he opined that it may have been as high as 62 percent of the PCBs produced worldwide were produced by companies other than Monsanto.

Are you familiar with that testimony?

A. No.

Q. Are you in possession of any information that would contradict Mr. Coghlan's testimony?

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MR. LAND: Objection, misleading as to what his testimony was, but go ahead.

THE WITNESS: I've read some papers that have attempted to do global inventory, and they have generally said that it was about 50-50 between Monsanto and other manufacturers.

BY MR. GOUTMAN:

Q. But you're not aware of the City of Spokane's expert witness testimony on that; correct?

A. No.

Q. And we discussed last time the ability of analytical chemists, assuming the same chlorine weight of a particular PCB, whether they can distinguish between a Monsanto PCB and a Kanechlor made in Japan; correct?

A. I'm not sure I understand the question.

Q. Can -- I think you conceded that you didn't know whether an analytical chemist looking at a PCB sample of a Kanechlor of, say, 60 percent chlorine weight and a Monsanto

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MR. LAND: And --

MR. GOUTMAN: It's a speaking objection. That's inappropriate. You're trying to coach the witness on what to say.

MR. LAND: I'm trying to make sure we get fair and accurate testimony.

MR. GOUTMAN: No, no --

MR. LAND: I think you're trying to get a misleading statement --

MR. GOUTMAN: No, no.

MR. LAND: -- and that's what I'm trying to prevent.

MR. GOUTMAN: No, I'm not. I'm asking a very clear question and you're about to give a speaking objection and I'm not going to put up with it.

BY MR. GOUTMAN:

Q. I asked you a very clear question.

Can an analytical chemist looking at a commercial Kanechlor of 60 percent chlorine and also looking at an Aroclor 1260, is he -- would that, he or she, analytical chemist be able to distinguish between or tell which is the Kanechlor and which is the

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Aroclor?

MR. LAND: Objection, incomplete hypothetical and vague.

THE WITNESS: I don't --

MR. LAND: Go ahead.

THE WITNESS: -- I don't know.

BY MR. GOUTMAN:

Q. Okay.

(Counsel confer.)

A. Excuse me.

(Counsel confer.)

Q. While we're getting the book, you're familiar with Mitchell Erickson's work on analytical chemistry of PCBs; correct?

A. Yes.

Q. And you probably have his book on your shelves; correct?

A. I don't know if I have it on my shelves, but I've certainly seen it.

Q. Yeah. This is it; right (indicates)?

A. Yes.

MR. GOUTMAN: Okay. The record will reflect I'm waving Dr. Erickson's book.

in the composition of the dominant congeners among the Japanese, French, American, and German mixtures."

Is that what it says?

A. Sorry. I was a little lost.

Q. Okay.

MR. LAND: It's right there (indicating).

THE WITNESS: Yeah, yeah.

Yes, that is what it says.

BY MR. GOUTMAN:

Q. Okay. And you have no basis to contradict that; correct?

A. This edition is from 1997, and we didn't have very good analytical chemistry back then, so I'm not sure that that conclusion's still true.

Q. Do you have -- listen to my question.

A. Okay.

Q. Do you have any basis for contradicting that statement?

MR. LAND: Objection, asked and answered.

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BY MR. GOUTMAN:

Q. That there are striking similarities in the composition of dominant congeners among the Japanese, French, American, and German mixtures.

MR. LAND: Objection, vague, and asked and answered.

THE WITNESS: No, I don't have -- I -- I agree with -- that that's what it says. I agree with that statement. I have no basis to contradict that statement.

BY MR. GOUTMAN:

Q. Thank you.

So just to backtrack, you can't state to a reasonable degree of scientific certainty if based upon the -- simply the analytical chemistry computer readouts that you're relying upon in this case that what is being identified as an Aroclor is actually made by Monsanto as opposed to some other manufacturer; correct?

MR. LAND: Objection, vague, incomplete hypothetical, and misleading.

Go ahead.

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Q. No, you didn't -- you brought in evidence extrinsic to simply looking at the data. Since you've conceded that you have no information that would contradict Dr. Erickson's statement that there are striking similarities among the various commercial mixtures of PCBs manufactured around the world, just looking at the analytical data from Spokane, you can't state that those PCBs are Monsanto's as opposed to Kanechlors from Japan or Prodelec from Czechoslovakia or France; correct?

MR. LAND: Object. Objection, misleading, vague, asked and answered, compound.

THE WITNESS: Should I answer?

It is correct. For any individual sample, you cannot tell.

BY MR. GOUTMAN:

Q. And you don't know factually the extent to which PCBs may have been -- imported PCBs may have been used at any Spokane facility, do you? You haven't done that investigation, have you?

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A. That's correct.

Q. And you don't know the extent to which there may have been atmospheric deposition of PCBs produced in Asia on to the West Coast of the Continental U.S., do you?

A. That's correct, I do not know.

Q. Okay. So you got data, and the source of the data was Baron & Budd and the Task Force, correct --

A. Correct.

Q. -- two sources?

With respect to --

(Counsel confer.)

Q. With respect to that dataset, did you review any QA/QC documentation from the laboratories involved?

A. Yes.

Q. Which -- let me ask you this.

Did you review any of the labs' quality assurance and quality control manual or guideline?

A. No.

Q. Did you review any analytical method validation protocol related to the

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testing performed in this case?

A. I don't remember.

Q. Did you review any analytical method or protocol used to analyze samples in this case?

A. Well, I've reviewed method 1668, which was what was used to analyze the samples.

Q. Okay. Did you review any of the laboratories' particular protocols?

A. No.

Q. You're aware that laboratories have their own protocols; correct?

A. They have their own SOPs, yes.

Q. But you didn't review any of the labs' SOPs here; right?

A. That's correct.

Q. Did you review any documentation of any deviations from written method or protocols applicable to the testing done in this case?

A. No.

Q. Did you review the laboratory sample book for the tests at issue?

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procedures and protocols are used to ensure that the results you are getting are accurately identifying and quantifying that which you are attempting to measure; correct?

A. Correct.

Q. And without the appropriate documentation of QA/QC measures, you can't make a determination as to whether the data is valid; correct?

MR. LAND: Objection, incomplete hypothetical.

THE WITNESS: Most of the data that I used was from the Washington State database, the EIM database, and it's quality assurance reviewed before it goes into that database, so I think based on that, you can assume that the data is valid and it is measuring what it's representing to measure.

BY MR. GOUTMAN:

Q. Answer my question.

Without appropriate and properly documented QA/QC, one cannot determine whether the data is valid; correct?

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MR. LAND: Objection, misleading, incomplete hypothetical.

THE WITNESS: Correct.

BY MR. GOUTMAN:

Q. Having not reviewed the categories of QA/QC documentation that we discussed a second ago, as you said in your prior answer, it is your assumption that the data is valid; correct?

MR. LAND: Objection, misleading, mischaracterization of testimony.

Go ahead.

THE WITNESS: Again, based on the fact that most of it was from the EIM database, I think it's safe to assume that it's valid data.

BY MR. GOUTMAN:

Q. Okay. Again, it is your assumption; correct?

MR. LAND: Objection, misleading.

THE WITNESS: It -- you know, when you look at the database, it says -- the documentation for the database says that everything that's gone in here has been

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MR. GOUTMAN: Okay. You want to take a break for lunch?

MR. LAND: Let's do it.

MR. GOUTMAN: There's a place downstairs called Pagano's. It's pretty quick.

THE VIDEOGRAPHER: We are going off the record at 12:01.

(A recess is held from 12:01 p.m. to 12:46 p.m.)

THE VIDEOGRAPHER: We are back on the record at 12:46.

BY MR. GOUTMAN:

Q. I'd like to go back to some questions on the data that you reviewed.

Your purpose, as we discussed, to quote from your report, was to examine congener patterns in data samples; correct?

A. Correct.

Q. And you did not choose the number, location, or time of the data samples, they were essentially chosen by you -- by the people who ran those tests and provided you with the data; right?

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A. Correct.

Q. So you did not independently attempt to design a sampling program that would attempt to characterize any particular environmental compartment river-wide, the, whatever, how many miles between Idaho and the Columbia River; correct?

A. That's correct.

Q. And you did not attempt to characterize any environmental matrix with respect to the time of year because you know that flow characteristics change by time of year; correct?

A. Correct.

Q. So you are simply making conclusions about the samples that you were given and not claiming that these are in any way representative of the entire river with respect to any single environmental compartment; correct?

MR. LAND: Objection, misleading, compound.

THE WITNESS: Can you repeat the question?

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BY MR. GOUTMAN:

Q. You -- let's step back.

You did not design a sampling program for any of these particular environmental compartments; correct?

A. Correct.

Q. And in designing a sampling program, one might try to design it in such a way that you are trying to do representative sampling that will characterize the river in its entirety for any particular time during the year; correct?

A. You might do that, yes.

Q. Okay. But that wasn't done here; correct?

A. There was an attempt to do that by the people that designed those studies.

Q. Okay. What I'm saying is with respect to the actual data that you reviewed, you are not making a claim that it is representative with respect to any of these environmental compartments, that that sampling is representative of the entire river for 12 months out of the year; correct?

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A. That is not something that I claimed in my expert report, correct.

Q. Okay. Now, you -- do you know, for example, with respect to the surface water samples, do you know whether they were taken during the critical season or non-critical season?

A. I'm not sure how you define "critical season."

Q. Do you -- do you understand those phrases as how they are used for the Spokane River?

A. No, I don't know. I've not heard the term "critical season" used with respect to the Spokane River.

Q. Do you -- do you understand that the river flows, the volume increases and velocity increases at certain times of year?

A. Yes.

Q. I think we've covered that.

Do you know what -- whether -- with respect to any of these surface water samples, whether they were taken during high velocity or low velocity periods of time?

Kentucky, Minnesota, or Florida, it's all mixed together?

A. Well, I'm assuming your samples are all tagged with latitude and longitude.

Q. Yeah, I understand that, but in the PMF analysis in this hypothetical, you're mixing them all together, you're including them in the same analysis, right, and you're identifying factors; correct?

A. Yes.

Q. So isn't it true that geographic heterogeneity might limit the extent to which a PMF analysis can give you useful information?

MR. LAND: Objection, misleading, incomplete hypothetical.

THE WITNESS: As long as your samples are tagged with latitude and longitude, you can back out the spacial information, so I don't think it limits you.

BY MR. GOUTMAN:

Q. Okay. Going back, you put -- you put this -- load this data into your computer

and you ask your computer model to generate factors, what's called factors; correct?

A. Correct.

Q. And you compared those factors to certain Aroclors; correct?

A. Correct.

Q. And in your report you identify specifically your methodology, and you -- if I can find it -- I believe compared it to 1016, Aroclor 1242, 1248, 1254, and 1260; correct?

A. Correct.

Q. So that was your methodology. And you did not compare the factors to byproduct profiles; correct?

A. When I found factors that were not similar to any of the Aroclors, I did compare them with what I knew about inadvertent PCBs.

Q. That wasn't my question and I think you know it wasn't my question.

You did not design this by -- by comparing by way of PMF analysis any non-Aroclor profiles, you used only Aroclor profiles; correct?

MR. LAND: Objection, misleading,

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incomplete hypothetical.

THE WITNESS: The PMF analysis just spits out the fingerprints. It has nothing to do with whether things are Aroclors or not. And then I took the fingerprints and compared them with Aroclors.

BY MR. GOUTMAN:

Q. So the answer is, yes, you did not -- you did not take what the computer spat out, the factors, right, and compare them to byproduct profiles?

MR. LAND: Objection, misleading.

THE WITNESS: I did. When -- when the factors did not look like Aroclors, I then went and compared them with what I knew about inadvertent byproduct PCB fact -- fingerprints.

BY MR. GOUTMAN:

Q. Which byproduct fingerpint -- prints did you identify and use and in what publications did you take them from?

A. There's a paper by Nakano where he has fingerprints for PCBs in silicone products. I used that.

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Q. What was the R^2 value for that?

A. I don't remember.

Q. So why didn't you submit that analysis in your report?

A. I did it visually. I didn't do it in terms of actual numbers.

Q. Well, this is my question.

In terms of actual numbers --

A. Okay.

Q. -- so you can generate an R^2 value, the quantitative result that scientists can look at instead of just sort of trying to peer subjectively in your head, okay, did you calculate any R^2 values for any of the factors based upon byproduct profiles found in the literature?

A. No.

MR. LAND: Objection, misleading.

THE WITNESS: Sorry.

BY MR. GOUTMAN:

Q. And that is something you could have done; correct?

MR. LAND: Objection, incomplete hypothetical.

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THE WITNESS: In some cases, yes.

BY MR. GOUTMAN:

Q. What would have prevented you from doing that?

A. The byproduct PCB signatures vary quite a bit from what I've seen in the literature, so it would be difficult to know which ones to use. There are many published ones.

Q. Why not use all of them? What would prevent you from doing that?

A. That would be possible.

Q. And, in fact, there are byproduct profiles for numerous products that you are not even aware of, for example, the products that were listed in Page 100 of Exhibit 9. Do you recall that?

MR. LAND: Objection, compound, vague.

BY MR. GOUTMAN:

Q. Correct?

MR. LAND: What are you asking there?

MR. GOUTMAN: What am I asking? I'm

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asking the question I asked.

BY MR. GOUTMAN:

Q. In fact, there are by -- there are byproduct profiles for numerous products that are -- that you are not aware of that are, for example, listed in products in Exhibit 9 that we discussed in some detail; correct?

MR. LAND: Objection, vague, incomplete hypothetical.

THE WITNESS: Presuming that the products listed in that table really do have PCBs in them, then, yes, there may be other fingerprints that I'm not aware of.

BY MR. GOUTMAN:

Q. And for purposes of preparing your report, you did not go out and research any of these products that are listed in Exhibit 9 to determine what, if any, information there is on byproduct PCB profiles in these products; correct?

A. Only for the pigments in the -- in the silicones.

Q. And you certainly didn't compare them to any byproduct profiles from the

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incineration literature which we've already discussed you were not familiar with; correct?

A. I am familiar with some of the incineration literature. I have some knowledge of what the fingerprints look like out of incinerators, and so I had -- I had that in mind when I was looking at the fingerprints, but I did not numerically compare them, no.

Q. The only thing you numerically compared the factors to were Aroclors; correct?

A. Correct.

Q. And then after comparing them, you used three criteria according to Page 14 of your report; correct?

A. I'm sorry. What was the question again?

Q. You used three criteria, did you not, for determining whether the PMF identified a non-Aroclor source; correct?

A. Yes.

Q. And the first one is that it should not resemble any Aroclors; right?

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A. Correct.

Q. And you used -- calculated an R2; correct?

A. Correct.

Q. And you used cutoffs of the R2; correct?

A. Yes.

Q. And these cutoffs were 0 to 4 unknown, 4 to 8 -- I'm just talking about .8, .4 and .8, weathered and above .8 I assume Aroclor; correct?

A. They're approximate. 0 to .4 was considered to be either highly weathered or an unknown source. .4 to .8 was considered to be a weathered Aroclor. And above .8 was considered to be a relatively unweathered, fresh Aroclor.

Q. Okay. And because you're comparing them only to -- quantitatively comparing them only to Aroclors, you knew that the results would only give you the extent to which it looks like an Aroclor quantitatively and not the extent to which it looks like a byproduct PCB pattern; correct?

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MR. LAND: Objection, misleading.

Go ahead.

BY MR. GOUTMAN:

Q. By the very design of your analysis; correct?

A. The R2 shows you how similar it is to an Aroclor, yes.

Q. And not how similar it is to a byproduct PCB; correct?

A. Correct.

Q. And we've discussed in some detail in your previous deposition these cutoffs, and I asked you the following question at Page 133 of your deposition:

"I couldn't look in a handbook, textbook, or peer-reviewed article which will tell me that a sample with an R2 value of .5 is either a weather -- weathered Aroclor, something that never was an Aroclor, or something that always was an Aroclor?"

And you answered, "Correct."

A. Yes, that's what I answered.

Q. And that would be your answer today; correct?

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A. Correct.

Q. And I asked you:

"If I were to say -- tell you that in my opinion the upper cutoff limit of .8 should be .9, how would you disprove that?"

And you answered, "I couldn't disprove it."

MR. LAND: Right real quick. If you remember that from memory, then go ahead and answer, but if you need to review --

MR. GOUTMAN: Yeah, we'll --

MR. LAND: -- the document to make sure --

MR. GOUTMAN: -- we can waste everyone's time.

MR. LAND: Well, I'm saying you can ask in different ways. If she agrees with it now, that's one thing, but if we're going to ask if that's exactly what she said --

MR. GOUTMAN: Well, I'm going to ask it the way I want to --

MR. LAND: -- I think we should --

MR. GOUTMAN: -- and you can make

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Q. I'm at Page 133, and we'll do this the hard way. Okay?

Question Page -- Line 3:

"Let me ask it this way -- in this way -- let me ask it this way. I couldn't look in a handbook, textbook, or peer-reviewed article which will tell me that a sample with an R2 value of .5 is either weather -- a weathered Aroclor, something that never was an Aroclor, or something that always was an Aroclor?"

And your answer was what --

A. Correct.

Q. -- and that is true today; correct?

A. Correct.

Q. And I asked you:

"If I were to tell you that in my opinion the upper cutoff limit of .8 should be .9, how could you disprove that?"

And what was your answer under oath?

A. "I couldn't disprove it."

Q. And that is true today; correct?

A. Correct.

Q. And then I asked:

"If I were to say the lower cutoff should be -- instead of .4, it should be .5, .6, .7, how would you scientifically disprove that?"

And your answer was?

A. "I can't disprove it."

Q. And that answer is true today?

A. Yes.

Q. And am I correct that these cutoffs that you used here have never been subjected to a peer review in a peer-reviewed journal?

A. Correct.

(Counsel confer.)

MR. GOUTMAN: I'd like to show you a Exhibit 19, which is a paper that you cite in your report.

(Exhibit Rodenburg-19, two-page document entitled Determination of Polychlorinated Biphenyls Using Multiple Regression With Outlier Detection and Elimination, is marked for identification.)

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MR. GOUTMAN: For the record, this is a paper by Burkhard, B-U-R-K-H-A-R-D, and Weininger, W-E-I-N-I-N-G-E-R, titled "Determination of Polychlorinated Biphenyls Using Multiple Regression With Outlier Detection and Elimination."

BY MR. GOUTMAN:

Q. And you're familiar with this article; right?

A. Yes.

Q. And just if you go to the second page, they're talking about COMSTAR; is that correct?

A. Yes.

Q. And that's a PMF program similar to the one that you use?

A. No, COMSTAR is different.

Q. It is a -- it is a method of PMF analysis; correct?

A. No, as I understand it, COMSTAR is more of a MLR, similar to MLR.

Q. It -- I understand. Okay. Fair enough.

But what it sets forth here, and

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this is, again, a paper that you cited, it sets forth R2 values that the authors deem acceptable. And it says, and I'm quoting in the second page right here (indicating) --

A. Uh-huh.

Q. -- "From our experiences with COMSTAR, acceptable COMSTAR solutions are obtained when the following conditions occur: First, R2 for the analysis is greater than .9."

Is that what it says?

A. That's what it says.

Q. And right above that it says, the fourth table, Table 1, a turtle sample -- by the way, this is about analysis of PCBs; right?

A. Yes.

Q. "The fourth sample, a turtle sample, illustrates the behavior of COMSTAR with severely imperfect input data. For this sample, COMSTAR analysis failed, i.e., COMSTAR was unable to find a subset of PCB peaks which forms a self-consistent PCB population. This failure is shown by the smaller R2 value, 725"; correct?

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A. That is what it says.

Q. Now, I don't know if I asked you this, but these cutoffs that you include in this report, do they appear -- I think I asked you whether you've ever published in the peer-reviewed literature.

Have you ever seen it anywhere else in a study in a peer-reviewed journal?

A. No.

Q. The second criterion that you used, it says -- this is on Page 14 of your report, the second full paragraph.

A. Hold on. I lost my report. Is it -- yeah, here we go. Okay. What page?

Q. Page 14.

A. Okay.

Q. Second full paragraph, the second criteria is that -- I'm just quoting from your report -- is that, "When the agreement between Aroclor and the factor is less than .4, the differences between the Aroclor and the factor cannot be explained by any known weathering phenomenon."

Is that what it says?

dechlorination of -- of Aroclors.

BY MR. GOUTMAN:

Q. But -- but my question is: Some of those same congeners that are, quote, as you say, typically produced by dechlorination may also be congeners created as byproduct PCBs; correct?

A. That's correct.

Q. And so how can you tell them apart? Like what scientific test can you do so that another scientist can say, "Oh, yeah, that is dechlorinated as opposed to a congener that was created as a byproduct PCB and was never an Aroclor"?

A. Well, again, you compare the fingerprint that's generated to known weathering processes; and if it is similar to a known weathering process that you know is based on a weathering result of an Aroclor, then you can make the -- the conclusion that that PCB came from the Aroclor -- you know, it's just been weathered, but it originally came from an Aroclor.

Q. So that sounds circular to me.

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extent that there are known fingerprints of some by -- of all byproduct PCBs; right?

A. Correct.

Q. And would it be safe to assume that there are not known fingerprints for all chemical processes that might produce byproduct PCBs?

MR. LAND: Objection, vague.

BY MR. GOUTMAN:

Q. You're pretty familiar with the literature, are you not?

A. Yeah, I think I just answered that question previously, but that for many of the processes listed in that report, we don't know what the congener fingerprints of any -- if there are any PCBs produced, we don't know what their congener fingerprints might look like.

Q. Okay. Let's take a look at the actual results here for PMF for surface water.

A. Excuse me.

Q. I'm sorry. I looking at the wrong page. Page 17 you give R2 values for surface water. And am I correct that -- for the five

factors; correct?

A. Correct.

Q. Am I correct that only one of them is above .9?

A. Correct.

Q. So all of the R2 values are below .9 except for Aroclor 1254; correct?

A. For the surface water, yes.

Q. Yes. And, in fact, they are all below .8 except for Factor 4, 1254; correct?

A. That's correct.

Q. Page 19 of your report you discuss fish tissue; is that correct?

A. Correct.

Q. And am I correct that the highest R2 value is .67; right?

A. I'm trying to find that.

Q. Page 19.

A. Yes, that's correct.

Q. And the other one is .46; right?

A. Correct.

Q. So none of them are obviously above .9; correct?

A. Correct.

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Q. And none of them are above .8; correct?

A. Correct.

Q. See, I'm really good at math.

For stormwater, am I correct that none of the values are -- R2 values are above .9?

A. Correct.

Q. And I'm sorry for skipping around, but if we go back to 18, Page 18, "Spokane City wastewater treatment influent and CSO samples," you see that?

A. Yes.

Q. You say that -- well, first of all, the results -- none of the -- well, let me just read what you say.

"Four of the five factors resembled Aroclors." The first factor strongly resembled a 50-50 mixture of Aroclors 1242 and 1248, R2 equals .92.

I thought your methodology was to compare the factors to the five Aroclors.

A. Yes.

Q. Okay. So where are we getting a

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Q. But it -- the reader of this report would not be able to tell what those byproduct congener concentrations are other than they're found in pigments other than 11 and 209; correct?

A. Correct.

Q. And also you did not discuss congeners found in any of the other 200 or so products that might potentially contain byproduct PCBs that we discussed in Exhibit 8; correct?

A. I did discuss silicone.

Q. Other than silicone?

A. No, not other than silicone.

Q. And you did not discuss the likeness or unlike -- or, excuse me, the presence and concentration of PCBs -- byproduct PCBs that are known to be generated by incineration?

A. Correct.

Q. So of the universe of byproduct congeners -- excuse me -- of products that may contain byproduct PCBs, you narrowed that universe essentially to pigments in silicone;

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right?

A. I would say that those are the two that I specifically considered.

Q. And -- and, in fact, with respect to pigments, you narrowed the universe from the dozens of congeners to two, 11 and 209; correct?

A. I'm sorry. Can you repeat that?

Q. With respect to just pigments, you narrowed the universe of congeners that are -- number in the dozen, byproduct congeners that are in the dozens down to two, PCB-11 and 2 -- 209; correct?

A. Those are the two that I specifically reported.

Q. Why is blank correction important?

A. When you analyze samples for PCBs, you frequently find PCBs in the blanks, and so you need to correct that to account for the fact that PCBs are present in the blanks, that some of the PCBs that you measure in the sample might be there because of blank contamination in the lab or in the field.

Q. And you've referred to it in some

of your PowerPoints as a -- potentially a significant problem --

A. Yes.

Q. -- correct?

And -- and in your October seminar which we watched --

A. Which one was that?

Q. The Task Force --

A. Oh, at the -- at the IPCB? Yes.

Q. You said -- and I don't have the transcript, so you tell me if it sounds like something you said. If not, I'll accept that, but what I wrote down was, "Just here in Spokane we did a study of the lab blanks because, you know, lab blanks are a big issue in the Spokane River and concentrations in the river are fairly low, so the blanks are a significant contributor to that."

Does that sound like something you said?

A. Yes.

Q. And you characterized the PCB concentrations in the river as "fairly low"; is that correct?

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A. Correct.

Q. And you have recommended, and we -- I can show you a recent PowerPoint, three approaches to blank correction; is that correct?

A. I don't remember that. I -- we provided yesterday the paper that we just published.

(Counsel confer.)

(Exhibit Rodenburg-21, multipage document entitled Source Apportionment of PCBs in the Spokane River: Blank study and preliminary results, is marked for identification.)

BY MR. GOUTMAN:

Q. So we marked as Exhibit 21 one of your PowerPoint presentations.

A. Yes.

Q. Okay. And to whom did you give this presentation?

A. I don't remember.

Q. Okay.

A. I'm guessing it was for the Task Force.

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BY MR. GOUTMAN:

Q. Okay. And you can't tell us what type of blank correction was done with respect to any environmental compartment other than stormwater; right?

MR. LAND: Objection, misleading, mischaracterizes prior testimony.

THE WITNESS: Again, I did look at the QAPPs. I don't remember the -- the specifics for each study and there was one study, I believe it was groundwater...

(Reviewing document.)

Yeah, it was the Kaiser groundwater that I had to manually blank correct because it was not already blank corrected when I received it.

BY MR. GOUTMAN:

Q. That wasn't my question.

My question is: You don't know the method of blank correction for any environmental compartment other than -- I'm sorry, the groundwater at Kaiser and the surface water; correct?

MR. LAND: Objection, misleading,

mischaracterizes prior testimony, but you can answer.

THE WITNESS: Again, I don't remember the specifics.

BY MR. GOUTMAN:

Q. I would like to now turn to the MLR that you performed on data, leaving aside the MLR testing that you just told us about an hour or so ago that we weren't aware of, but the MLR data that -- the MLR data that you actually discuss in your report. Okay?

And once again, your report gives -- you're -- you're comparing the data, am I not correct, to known Aroclor patterns; correct?

A. Correct.

Q. And that would be 1016, 1242, 1248, 1254, and 1260; right?

A. And as I mentioned in my errata, I -- I did a little bit with 1262 and 1268.

Q. We're going to get to that.

At least in this report you did not do 1262 and 1268; correct?

A. Correct.

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Q. And am I correct that in your MLR you did not compare the data to any byproduct patterns quantitatively; correct?

A. Correct.

Q. Am I correct then that, as a result, all you were finding out is the extent of the resemblance to Aroclor profiles and not the resemblance to byproduct profiles? Correct?

A. Correct.

Q. And, again, you used the R2 cutoffs that we discussed in some detail earlier; correct?

A. Well, I reported every R2 and then I, in my interpretation, I did follow those guideline cutoffs, yes.

Q. Okay. And once again, when you looked at whether there was a resemblance to byproduct PCBs, you limited your discussion to two of the congeners found in pigments, correct, PCB-11 and 209?

MR. LAND: Take your time to look through your report if you need to.

THE WITNESS: (Reviewing document.)

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I talked about PCB-7.

BY MR. GOUTMAN:

Q. What page?

A. That is Page 38 under the surface water CLAM samples.

Q. Anything else?

A. (Reviewing document.)

Those are the only ones that I mention -- mentioned quantitatively.

Q. So there is one mention of PCB-7, and otherwise you were comparing them to two of the -- two of the many congeners found in pigments PCB-11 and 209; correct?

A. PCB-11 and PCB-209 and PCB-7 are the only congeners that I specifically quantitatively pointed out.

Q. What are negative coefficients?

A. They're coefficients that are less than zero.

Q. And the problem with that, at least from a lay perspective, is that it's difficult to get your mind around how there can be a negative amount of something; correct?

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A. Correct.

Q. So when you -- your MLR spits out a coefficient that's less than zero, you told us that that was -- that Aroclor was removed from the regression and the MLR was run again; correct?

A. Correct.

Q. And did you continue to rerun the analyses until all the negative coefficients were removed?

A. Yes.

Q. And, therefore, you would not report in Table 3 which sets forth all of your MLR results; right? Page 25.

A. I would not report what?

Q. Okay. Let's start again.

You would not report an Aroclor present in Table 3, which presents the results of your MLR analysis, if, in fact, that Aroclor had a negative coefficient; correct?

A. Correct.

MR. GOUTMAN: Why don't we mark this as Exhibit 22.

(Exhibit Rodenburg-22, multipage

spreadsheet of raw data Line 1 labeled BB(1809040-03) First Run, is marked for identification.)

BY MR. GOUTMAN:

Q. This is a raw data file that you provided us.

Does it look familiar?

A. Yes.

Q. Okay. And I want to direct your attention to Table -- could you open Table 3 in your report, Page 26?

Got it?

A. Uh-huh.

Q. I direct your attention to the top sample, Biofilm. You see that?

A. Yes.

Q. You report number of peaks, detected peaks, so forth and so on; and you say that Aroclor 1242, 1248, 1254, and 1260 are present; correct?

A. Correct.

Q. If you turn to Exhibit 22, the third page in, Line 74, you see the lines on the left?

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A. Yes.

Q. This is -- so we're looking at the same sample, if you look at the sample numbers on -- in your report --

A. Yes.

Q. -- and the sample number of Exhibit 22, it's the same. So we're looking at the same sample; correct?

A. Yes.

Q. Okay. Now, am I correct that this sample reflected two runs; correct? First run and second run; right?

A. Yes, I think so.

Q. In the first run, 1016 had a negative coefficient; right?

A. Yes.

Q. So that was eliminated and you did a second run; correct?

A. Yes.

Q. And in the second run, 1242 had a negative coefficient?

A. That's what it shows here.

Q. And there's no third run?

A. I don't see one on this printout,

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no.

Q. As a matter of fact, you can look at your printouts and you'll never see a third run; isn't that right?

MR. LAND: Objection, misleading, vague.

Go ahead. If you know, you can answer or --

THE WITNESS: I don't see --

MR. LAND: -- answer.

THE WITNESS: -- the third runs in any of these, no.

BY MR. GOUTMAN:

Q. Okay. And so if we go to Table 3, you are reporting the presence of 1242 even though in your second run it had a negative coefficient; correct?

A. That sure is what it looks like.

Q. Let's go to the third -- and by the way, I have, Dr. Rodenburg, I have quite a few examples of this and it might take some time to go through.

A. Okay.

Q. Go ahead. The third line down,

"Biofilm Green Street"; right?

A. Yep.

Q. You present -- you say that the 1242, 1248, 1254, and 1260 are present; correct?

A. Yes.

Q. Why don't you go to Line 122, which is -- you see that?

A. Yes.

Q. So we're looking at the same sample, and would you agree with me that the first run 1016 was a negative coefficient, so you eliminated that; correct?

A. Yes.

Q. And the second run 1242 was a negative coefficient; correct?

A. Yes.

Q. And, nonetheless, you reported it as being present in Table 3; correct?

A. Yeah.

Q. And, by the way, it is the recognized rule, if you will, that you continue to run them -- run the MLR until all negative coefficients are eliminated; correct?

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Do I have to pull out a paper that says that or are you going to accept that?

A. I accept that, yeah.

Q. Okay. Okay. Let's go to the one, two, three, four, five, six -- and I'm sorry. There was no third run here; correct?

A. Correct. Well, I don't see one in these printouts.

Q. Okay. Let's go to the one, two, three, four, five -- six line down, River Sediment, Gonzaga.

Do you see that?

A. Yes.

Q. And it reports the presence of 1242, 1254, and 1260; correct?

A. Yes.

Q. Let's go to 194, which is the same sample number; correct?

A. I'm sorry. What are you -- we're on Line 1 -- where are we?

Q. We're on Line 194.

A. Of the spreadsheet?

Q. Yes.

A. Yeah.

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Yes. Got it.

Q. Okay. So the first run of this sample shows a negative coefficient for 1016, so you eliminated that. And in the second run you have a negative coefficient for 1242; correct?

A. Yeah, I don't know what happened there.

Q. Nonetheless, you report that 1242 is present, correct --

A. Correct.

Q. -- in Table 3?

A. No.

Q. Okay. Let's go down to Hangman Creek on Table 3.

A. Can we take a break? Hold on one second?

(Pause.)

Okay. Yeah.

Q. Hangman Creek, you see that on Table 3?

A. Yeah.

Q. Okay. And --

A. Which one? There's several.

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Q. Well, it's Sample Number 16.

A. Okay.

Q. And that would be on page -- or Number --

MR. SORENSON: 266.

Q. -- 266.

A. Yep. Got it.

Q. Okay. Now, just the Table 3 that you submitted to this Court says that PCBs 1248 -- 1242, 1248, 1254, and 1260 are present; correct?

A. Yeah, sorry, I got lost. We're on Sample 16?

Q. Yeah.

A. Yeah. 1242, 1248, 1254, 1260.

Q. However, the -- your raw data says that you ran the MLR once and 1016 was a negative coefficient, so you eliminated it and ran it again. And the second run 1242 was negative and there's no third run, so -- but, nonetheless, you reported that 1242 was present in the sample; correct?

A. Correct.

Q. Now, let's go down to Mission

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Bridge, 76.6 in Table 3 --

A. Uh-huh.

Q. -- and go to Line 338.

(Counsel confer.)

Q. Got it?

A. Yes.

Q. And, first -- I'm sorry. You report that 1242, 1248, 1254, and 1260 are present in the report that you submitted to the Court; correct?

A. Correct.

Q. In fact, after the second run, you still had a negative coefficient for 1242; correct?

A. Correct.

Q. And there was no third run?

A. Correct.

Q. Okay. Let's go to Nine Mile Dam, Sample 19.

A. Hold on. I'm just checking some things.

Q. Nine Mile Dam, Sample 19. I'm leaving off all the -- I'm giving you only the last two digits of the sample for brevity

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sake.

And that -- there you report the presence, in the report you submitted to the Court, the presence of 1242, 1248, 1254, and 1260; correct?

A. Yeah. Can we take a break? I -- I'm getting lost in all these numbers.

MR. LAND: Yeah, can we take a break.

MR. GOUTMAN: Well, I --

MR. LAND: Is there a question pending or...

MR. HAASE: I believe there is.

MR. LAND: Yeah, I mean, that's fine. You can answer that question and then we can take a break.

MR. GOUTMAN: Sure.

BY MR. GOUTMAN:

Q. Are you confirming -- the pending question was: In your report, you say with respect to Nine Mile Dam, Sample 19, last two digits, in your report that you submitted to the Court --

A. Right.

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Q. -- you identified the presence of 1242, 1248, 1254, and 1260; correct?

A. Yes.

Q. Okay. So that was the pending question.

MR. LAND: Okay. Yeah, take a break.

THE VIDEOGRAPHER: We are going off the record at 2:45.

(A recess is held from 2:45 p.m. to 2:50 p.m.)

THE VIDEOGRAPHER: We are back on the record at 2:50.

BY MR. GOUTMAN:

Q. So, Dr. Rodenburg, can you confer [sic] that we took a break during which you looked at the various exhibits that -- or a couple of the exhibits that are in front of you?

A. Yes.

Q. And then you asked to speak to counsel --

A. Yes.

Q. -- to Plaintiff's counsel; is that

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correct?

A. That's correct.

Q. And did you speak with Plaintiff's counsel?

A. Yes.

Q. Okay. So where we were was at -- was it Nine Mile Dam? Is that right?

A. I think we went over the Nine Mile Dam sample.

MR. SORENSON: I think we just did the Aroclors.

MR. GOUTMAN: Yeah, we just did the Aroclors.

BY MR. GOUTMAN:

Q. If you turn to Number 386, Line 386 with respect to that Nine Mile Dam sample, am I correct that in the first run -- excuse me. In the second run there was a negative coefficient for 1242; is that correct?

A. That is correct.

Q. And there's no third run?

A. That's correct, not in this spreadsheet.

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Q. And are you suggesting that there are other spreadsheets because this is what you gave us?

A. There were a lot of spreadsheets.

Q. Okay. Okay. So are you testifying under oath that with respect to this sample there was a third run?

A. I don't know. I don't remember.

Q. Are you aware of any spreadsheet that would reflect the analyses of this sample, the MLR analyses of this sample, that would reflect a third run?

A. I -- I don't remember.

Q. Okay. Well, I'll represent to you that this is what you gave us and that's why we're discussing it with you.

So even though a negative coefficient was reforded -- ported for 1242, you in your report to the Court said that 1242 was present in this sample; correct?

A. Correct.

Q. Let's go to the next one, Plantes Ferry-Biofilm, Sample Number 05. You report 1242, 1248, 1254, and 1260 in your report to

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the Court; is that correct?

A. Correct.

Q. If you turn -- go to Line 410, am I correct that there are only two runs, and the second run 1242 was a negative coefficient; correct?

A. Correct.

Q. And, nonetheless, you report it present in your report to the Court; correct?

A. Correct.

Q. With respect to the next one, Plantes Ferry-Sediment, Number 24, once again you report all four of those Aroclors present, including 1242; is that correct?

A. Correct.

Q. And if you turn to Line 434, can we agree that on the second run 1242 is a negative coefficient --

A. Correct.

Q. -- correct?

And there's no third run --

A. Not --

Q. -- correct?

A. -- in this spreadsheet.

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Q. On the next one, which is, again, Plantes Ferry-Sediment, Number 24, once again you report all four Aroclors present including 1242; is that correct?

A. Yes.

Q. And if you go to number -- I'm sorry.

(Counsel confer.)

Q. Okay. By the way, you've mentioned or suggested the possibility that there was a third run that is not in the data that was turned over to us.

Let's go back to -- where were we? Well, let's -- did we ever...

(Counsel confer.)

Q. Okay. Could you go to Line 434? We're at Plantes Ferry, Sample 24. You report all four Aroclors present including 1242.

Can you agree that after the second run 1242 reflected a negative coefficient, but, nonetheless, you reported it as being present in your report to the Court?

A. Yes.

Q. And just so we're clear, the --

you report the R2 in the raw data; is that correct?

A. Yes.

Q. And the R2 you report is .776; correct?

Not you report, but in the -- excuse me. In the raw data, after the second run you report an R2 of .776; correct?

A. What line are you on?

Q. I'm on Line 453.

A. Ah, okay. Yeah, now I see it. Yes.

Q. Okay. And it's your convention to round up or down; correct?

A. Correct.

Q. So if you look at your report, for R2 for this sample, you report it as .78; correct?

A. Correct.

Q. Which is essential -- basically the same as the R2 you report after the second run; correct?

A. Correct.

Q. That would indicate that there was

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no third run; correct?

A. Again, I guess not. I...

Q. Well, it would be incredibly coincidental to have the same R2 in the first run and -- the second run and the third run; correct?

A. No, not necessarily.

(Counsel confer.)

Q. If you go back to 386 --

A. 386?

Q. Yeah. So we're -- and that was with respect to Nine Mile Dam --

A. Yes.

Q. -- 19, and the second run you report a R2 of .937; correct? Right?

A. Where? Sorry.

Q. It's --

A. So lost.

Q. -- Line 405.

A. 405. Okay.

Q. 937; right?

A. Yes.

Q. And in your report to the Court, you rounded it up to .94; right?

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A. Correct.

Q. Okay. Where are we?

(Counsel confer.)

Q. With respect to the Spokane Gage, Sample 15, which would be the third from the top, you report the presence of 1016, 1248, and 1254, correct, in your report to the Court?

A. Correct.

Q. If you go to Line 458, we have the first run. And then in the second run, which is Line 471 about, 1016 has a negative coefficient; correct?

A. Sorry. What line are we on again?

Q. 4 -- about 471.

A. Okay.

Q. 1016 has a negative coefficient; correct?

A. Yes.

Q. Nonetheless, you reported it as being present in the sample in your report to the Court; correct?

A. Yes.

Q. Let's turn to Page 27 of your

report.

MR. GOUTMAN: Oh, I have over 30 of these, so I'm sorry to be tedious, but -- and I know you want to catch a plane, but...

MR. LAND: Go ahead.

BY MR. GOUTMAN:

Q. The second line down, Seven Mile Bridge, Sample 18, do you see that?

A. Yes.

Q. You report to the Court that 1242, 1248, 1254, and 1260 were found; correct?

A. Correct.

Q. If you go to Line 554, it reports two runs of that sample, does it not?

A. Yes.

Q. And the second run had a negative coefficient for 1242; correct?

A. Correct.

Q. Nonetheless, you reported it as being present in your report to the Court; correct?

A. Correct.

Q. Let's go to Upriver Dam, Number 6.

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You report the presence of 1242, 1248, 1254, and 1260 in your report to the Court; correct?

A. Correct.

Q. If you go to Line 626, starting at Line 626 it reports two runs; correct?

A. Correct.

Q. And on the second run there was a negative coefficient for 1242; correct?

A. Correct.

Q. Nonetheless, you reported it as being present; isn't that right?

A. Correct.

Q. And just so we're clear, the R2 that you report, which is Line 64, is .82, and that's identical to the R2 you report in Table 3 of your report; correct?

A. Correct.

Q. The next line is you -- Upriver Dam, Sample Number 20. If you go to -- you report, I'm sorry, to the Court 1242, 1248, 1254, and 1260 as being present; correct?

A. Correct.

Q. And if you go to Line 650, it shows two runs of that sample; right?

A. Correct.

Q. And on the second run there's a negative coefficient for 1242; right?

A. Correct.

MR. GOUTMAN: Okay. I want to show you Exhibit 23.

(Exhibit Rodenburg-23, multipage spreadsheet of raw data Line 1 labeled 1308073-01 First Run, is marked for identification.)

THE WITNESS: Sorry.

Thank you.

BY MR. GOUTMAN:

Q. And I want you to turn in your report -- by the way, 23 is raw data that you turned over?

A. Yes.

(Counsel confer.)

Q. So I want you to go to Page 31 of your report, and the third one down -- third one from the bottom, excuse me, "River sediment," do you see that?

A. Yes.

Q. Spokane River near Hamilton,

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Sample 13.

A. Yes.

Q. And I want you to go to 362 of Exhibit 23. Am I correct that that reflects two runs of the MLR; correct?

A. Correct.

Q. And that in your report to the Court you indicated that 1242 was present; right?

A. Correct.

Q. However, on the second run there was a negative coefficient for 1242; right?

A. Correct.

(Counsel confer.)

Q. Okay. Why don't we go to Page 32 of your report. Okay? Top -- top sample. It's Spokane River near Centennial Trail, Sample 04.

A. Uh-huh.

Q. You see that?

A. Yes.

Q. And you report 1242 as being present; correct?

A. Correct.

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Q. And go to Exhibit 23, Line 122, it reports two runs; is that correct?

A. Line 122 you said?

Q. 1 -- beginning at 122, 122 to 140.

A. Yes.

Q. It shows two runs; correct?

Is that correct?

A. I'm sorry. I'm just -- give me a minute.

Yes.

Q. And in the second run there's a negative coefficient for 1242; correct?

A. Correct.

Q. But you report it in your report to the Court as being present; right?

A. Correct.

Q. Okay. Skip one and we're going to go to Spokane River downstream of Upriver Dam, Sample 01. Okay?

A. Yes.

Q. You report 1242 as being present in your report to the Court; correct?

A. Yes.

Q. If you learn -- go to Line 2 of

Exhibit 23, which is your raw data, it reports two runs; right?

A. Correct.

Q. And on the second run, 1242 had a negative coefficient; correct?

A. Correct.

MR. GOUTMAN: Okay. I hand you another set of your raw data. It's Exhibit 24.

(Exhibit Rodenburg-24, multipage spreadsheet of raw data Line 1 labeled 1606061-1.1 First Run, is marked for identification.)

BY MR. GOUTMAN:

Q. And I want you to turn in your report to Page 3 -- Page 33, and about halfway down is river -- it's the first River sediment sample.

Do you see that --

A. Uh-huh.

Q. -- in Table 3?

It's Sample 26. It reports the presence of 1242; is that correct?

A. Correct.

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Q. And if you go to Line 170 of Exhibit 24, there are two runs -- beginning at 170, there are two runs; is that correct?

A. Yes.

Q. And on the second run, 1242 had a negative coefficient; correct?

A. Correct. This sample number is not exactly the same, and I don't know why. It's got a .1 at the end. I'm not sure why.

Q. Okay.

A. So I'm not a hundred percent certain that that's the same sample, but...

Q. Well, do -- okay.

The next one down is River sediment, Union Gospel Mission Dock. Do you see that, Sample 27?

A. Yes.

Q. And if you go to Line 194 -- by the way, you report 1242 as being present; is that correct?

A. 1242, yes.

Q. If you go to Line 194 of Exhibit 24, am I correct that that reflects two runs --

A. Correct.

Q. -- for that -- for that data?

And the second run 1242 has a negative coefficient; is that correct?

A. Correct.

Q. And, nonetheless, you reported it as having been present in your report to the Court; correct?

A. Correct.

Q. The next one down is Union Gospel Mission Dock, Sample 20. And, again, you report 1242 as being present; is that correct?

A. Yes.

Q. And if you turn to 122, am I correct that that would reflect -- of Exhibit 24 -- that would reflect two runs of that sample?

A. Correct.

Q. And the second run -- by the way, you -- the second run had a negative coefficient of 1242; correct?

A. Yes.

Q. And, nonetheless, you reported that as having been present; correct?

A. Correct.

Q. By the way, I've noticed that with respect to this sample, for example -- this sample, for example, you -- in the first run you had a negative coefficient for 1016, but you didn't have a negative coefficient for 1242, correct, looking at Lines 125, 126?

A. Correct.

Q. And then when you ran it again you had a negative coefficient for 1242 having eliminated 1016; right?

A. Correct.

Q. And if you had done a third run and eliminated 1242, you don't know if you'd have had a negative coefficient for 1248 or any of the other congeners, correct, having not done that run?

A. That's unlikely because the reason that 1242 and 1016 are related and will give you different results like that, that their results are paired or linked in some way is because they're so similar in congener pattern.

Q. Without having done a third run,

you cannot scientifically establish that 1248 or 1254 or 1260 is present in that sample, correct, using an MLR analysis?

A. I disagree. If it's -- if it's significant in both the first and second runs, I think that you can say that 1248, 1254, and 1260 are significant.

Q. Do you...

(Counsel confer.)

Q. Directing your attention to the Burkhard paper, which you cited there, is Exhibit 19, am I correct this is a, I guess, an authoritative paper?

You cited it; right?

A. Yes.

Q. And it says -- is it Dr. Burkhard?

A. I don't know.

Q. Okay. The Burkhard paper says in the right-hand column, it's first full paragraph on the first page, "When performing the regression analysis, negative coefficients (concentrations) for the Aroclor mixtures may occur. Since negative matter cannot exist, stage one forces all coefficients to be

non-negative using the following iterative process. Here, if any of the coefficients are negative, the most negative coefficient is removed by fixing it at zero (temporarily, see stage two) and the regression is rerun. This process was repeated until all of the coefficients are non-negative"; correct?

A. That's what it says.

Q. And according to this raw data, you didn't do that; right?

MR. LAND: Objection, vague, misleading, but go ahead.

THE WITNESS: I -- I need you to clarify your question. I did not follow this exact procedure, correct, in the -- in the -- in the results that you're looking at.

BY MR. GOUTMAN:

Q. Because you didn't do a third run when your second run showed a negative coefficient; correct?

A. Again, it's not in the spreadsheet, so I guess not.

(Counsel confer.)

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Q. Let's look at...

(Counsel confer.)

Q. Okay. The last Union Gospel Mission Dock study from your Table 3 of your report.

A. Uh-huh.

Q. Sample 21. You report 24 -- 1242 as being present; is that correct?

A. Correct.

Q. And if you go to Line 146 of Exhibit 24, which is your raw data, that reflects two runs; is that correct?

A. Correct.

Q. And on the second run you had a negative coefficient for 1242; correct?

A. Correct.

Q. Nonetheless, someone reviewing this report would -- could conclude that your MLR analysis showed that 1242 was present; correct?

A. Correct.

Q. And that would be mistaken; right?

A. Based on this spreadsheet, that would be mistaken.

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Q. Okay. Let's go down. River sediment, Long Lake Low. The first Long Lake Low, which is sample digits ending 112, do you see that?

A. Yes.

MR. GOUTMAN: And I'm going to hand you another spreadsheet of your raw data which we've marked as Exhibit 25.

(Exhibit Rodenburg-25, multipage spreadsheet of raw data Line 1 labeled 3458103-S First Run, is marked for identification.)

BY MR. GOUTMAN:

Q. Now, am I correct that in your report to the Court you state that 1242 is present; right?

A. Correct.

Q. If you turn to Exhibit 25, Line 98, it shows that there were two runs, is that correct, of that sample?

A. Correct, yes.

Q. And the second run you had a negative coefficient for 1242; is that correct?

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A. Yes.

Q. For the second Long Lake Low, sample 114, you show in your report 1242 present; is that correct?

A. Yes.

Q. If you go to Line 122, same page that you were on previously, it shows two runs of that sample --

A. Yep.

Q. -- is that correct?

And the second run 1242 is a negative coefficient; right?

A. Correct.

(Counsel confer.)

Q. Let's turn to Page 34. And a third -- Page 20 -- 34. I'm sorry. 34 of your report, Table 3, third -- third one in, third one down, River sediment, Sample 100-S. You see that?

A. Yes.

Q. You report 1242 as present --

A. Yes.

Q. -- is that correct?

Can you go back to Exhibit 23 and

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Line 266? I'm sorry.

(Counsel confer.)

Q. Okay. Line 386. I'm sorry. It shows two runs of that sample, the second one of which has 1242 as a negative coefficient; correct?

A. I'm lost. Which sample are we on again?

MR. LAND: Yeah, I am too.

BY MR. GOUTMAN:

Q. 386. I'm sorry. We're on Exhibit 23.

A. Yeah, I think I got the right exhibit. Yes --

Q. Okay.

A. -- I got the right exhibit.

Q. Line 386 --

A. Yes.

Q. -- reflects two runs of this data; correct?

A. Correct.

Q. The second one of which shows a negative coefficient for 1242 --

A. Correct.

Q. -- correct?

MR. LAND: What's the sample ID there? I'm a little lost.

THE WITNESS: Ends with 01.

MR. LAND: Okay. Gotcha.

BY MR. GOUTMAN:

Q. Nonetheless, you report 1242 in your report to the Court as being present; correct?

A. Correct.

Q. Let's go to the next one, which is River sediment Sample 04. And once again, you show 1242 as being present in your report?

A. Correct.

Q. If you go to your raw data Line 458, it shows that there were two runs of this data, the second of which showed a negative coefficient for 1242; is that correct?

A. Correct.

Q. And, nonetheless, you report it as having been present; correct?

A. Correct.

Q. Let's skip one and go to UPRD-SEDT

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Sample 02 in which you, again, report 1242 as being present; correct?

A. Correct.

Q. By the way, I forgot to ask you this question: All of these -- all of these instances where you're reporting concentrations of an Aroclor for which there is a negative coefficient and then reporting an R2 value --

A. Uh-huh.

Q. -- okay, and we've gone through, I don't know, a dozen or so of these instances, do you know what the R2 value would be if you had done a third run?

A. No.

Q. There's no way of knowing; correct?

A. No.

(Counsel confer.)

Q. Okay. River Sediment UR -- UPRD 02, you report 1242 as being present. If you go to Exhibit 23, Line 410, am I correct that after the second run there was a negative coefficient for 1242; right?

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A. Correct.

(Counsel confer.)

Q. Okay. If we go to the next one, River sediment 03, you report 1242 is present, but if you go to 434 -- didn't we just do that -- 434 on the second run there was a negative coefficient for 1242; right?

A. Correct.

Q. Okay. Can you put aside 23 and take out 24.

A. (The witness complies with the request of counsel.)

Q. Okay. In the next, LFP SedTraps, the next sample on your Table 3, Sample 1-1, it reports 1242 as having been present; correct?

A. Correct.

Q. And if you look at Line 1, it reflects two runs, the second of which showed a negative coefficient for 1242; correct?

A. Correct.

Q. The next one, Sample 1-2, in your report you say that 1242 is present. If you turn to Line 26, on the second run the 1242

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had a negative coefficient; correct?

A. Correct.

Q. If you go to the next one, Sample 1-3, you, again, report 1242. However, if you turn to your raw data Line 50, beginning on Line 50, on the second run 1242 had a -- excuse me. I'm sorry.

1242 had a negative coefficient, correct --

A. Correct.

Q. -- Line 63?

And in the next 1-4 sample, you report -- of River sediment you report 1242 as having been present. If you go to Line 74, the second run indicates that 1242 had a negative coefficient; correct?

A. Correct.

Q. And the next one, Sample 1-5, you report in your report 1242 as having been present. However, in your raw data Line 98, it would reflect that there was a second run in which 1242 had a negative coefficient; right?

A. Correct.

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MR. GOUTMAN: Exhibit 26 is another set of your data.

(Exhibit Rodenburg-26, multipage spreadsheet of raw data Line 1 labeled 1211029-03 First Run, is marked for identification.)

BY MR. GOUTMAN:

Q. And turn to Page 35 of your report. Top sample, "Storm drain solids," you see that?

A. Yep.

Q. You report -- it's Sample 02. You report 1242 as having been present; correct?

A. Correct.

Q. If you go to Line 98 of your raw data, am I correct that after the second run 1242 was a negative coefficient?

A. Correct.

Q. In your opinion, is it sound science to report the presence of Aroclors when an MLR analysis generates a negative coefficient?

A. No.

Q. Did you do that in this case?

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A. Yes.

Q. I'd like to also take a close look at Table 3 for another reason.

MR. GOUTMAN: And I'm looking at the clock and I'm trying to speed through this, but --

MR. LAND: I appreciate it. Go ahead.

BY MR. GOUTMAN:

Q. Would -- as a scientist, would you reasonably question the validity of analysis in which the same data is received from two different sources and different results are -- from the same sample are reported?

MR. LAND: Objection, vague, incomplete hypothetical.

THE WITNESS: It would depend on the circumstances.

BY MR. GOUTMAN:

Q. How about in this case?

A. I don't know.

Q. Let's take a look at -- let's take a look at Page 31 of Table 3 of your report and about halfway down -- I'll wait till

results for these samples suggest that more than 95 percent of the PCBs in these samples arise from Aroclors."

Do you see that?

A. Yes.

Q. How is that calculation made?

A. That was based on the R2 value 'cause R2 can be considered as a indicator of what percent of the variation in the sample is explained by the regression parameters.

Q. And so is there a peer-reviewed study or article or authoritative text that says that there is a -- that R2 could be used to indicate mass of the substance being analyzed?

For example, if the R2 is .5, then 50 percent is that chemical?

A. Can you repeat the question? I'm not sure what you mean.

Q. I just don't understand how you get from R2 to a conclusion about the mass.

So -- so is there anything in the peer-reviewed literature that you could point me to or a text that says that if an R2 -- if

you're doing an R2 and it's .5, hypothetically, that means that 50 percent of that is the substance that you are analyzing?

A. So, again, the R2, what I was taught in school, is that one way to interpret the R2 is that it is an indicator of how much of the variability in the sample is explained by the regression parameters. And --

Q. Correct.

A. -- since what we're regressing is concentration, that we can relate that back to the concentration of PCBs in the -- in the Aroclors.

Q. Isn't the R2 telling you the extent to which that sample looks like a particular pattern?

A. Yes.

Q. Okay. And if there is a low R2 value, say it's .4, right, that is telling you that it may not be that substance at all. It's not telling you that 40 percent of that sample is that substance; is it?

A. It's -- depends on how you interpret the R2.

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Q. Okay. So can you -- other than telling me it's what you learned in school, can you point me to any peer-reviewed literature that says that R2 translates into the percent of that substance in the sample?

A. I don't recall any off the top of my head, no.

Q. Just so we're clear, you can't cite to anything in the peer-reviewed literature or textbooks that says that you can translate the R2 to the percent of that substance in that sample; is that correct?

A. Not sitting right here, no.

Q. Also in analyzing the stormwater samples, you noted concentrations of PCB-11; correct?

A. I believe I noted percentages.

Q. Percentages. I'm sorry.

And how do you determine that, those percentage?

A. As a percent of total mass with non-detect set to zero.

Q. Okay. So you basically -- basically added them up; right?

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A. Yes.

Q. Okay. And you did not compare or add up other PCB congeners known to be created as byproducts of production processes; correct?

MR. LAND: Objection, misleading.

Go ahead.

THE WITNESS: The only thing that I reported a percentage for was PCB-11 and I think 209 and, again, PCB-7 in the CLAMs.

BY MR. GOUTMAN:

Q. And I don't have to ask that question over and over again, that's true with respect to all of your MLR analyses; correct?

A. Correct.

Q. Okay. So we accomplished something. We shaved off some time.

A. Every minute counts.

Q. Yep.

Storm drain solids, you say more than 95 percent of PCBs in storm drain solids collected come from Aroclors. Is that, again, from the R2 value?

A. Yes.

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Q. Same as the stormwater --

A. Yes.

Q. -- same method of determination?

A. Same method, yes.

Q. Same with the 90 percent, which you characterize as Aroclor, from the City of Spokane treated effluent?

A. Yes.

Q. And if -- looking at the Spokane treated effluent discussion, you say the R2 value is just .15 for Sample ID PR172157.

Do you see that?

A. Yes.

Q. Would that mean that that sample is only .15 or 15 percent Aroclor?

A. That's one way you could interpret the R2.

Q. And the rest would be byproduct?

A. You don't know what the rest could be.

Q. Well, what are the universe of possibilities? Aroclor? By "Aroclor," I mean commercially produced PCBs or non-commercially produced PCBs; right?

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A. They could be products of dechlorination.

Q. Turn to Page 37, Biofilm. You say 90 percent of the Biofilm is Aroclors; is that correct?

A. I said Aroclors account for more than 90 percent of the PCBs in the Biofilm samples.

Q. And is that the same method of calculation, that is correspondence with the R2 that we discuss with respect to stormwater and storm drain solids?

A. Yes.

Q. And with respect to river sediment, did you use the same methodology to determine that it was 95 percent Aroclor?

A. Yes.

Q. On Table 3 where it says "NS," what does that mean?

A. It means not significant.

Q. Which means what?

A. It means that the p value was not significant for any of the Aroclors.

Q. And why would the p value not be

MR. LAND: Objection, vague.

THE WITNESS: I agree that there are measurable concentrations of PCB-11 in the river.

BY MR. GOUTMAN:

Q. And you say in your report that you think that the -- you attribute the PCBs in -- by the way, Inland Empire uses recycled paper; right?

A. That's my understanding, yes.

Q. And you attribute the presence of P -- Aroclor, you believe Aroclor, in the effluent to -- to recycled NCR paper; right?

A. Well, what I said was, you know, that these -- the Aroclor 1242/1016 is present, and I said this is to be expected given that Aroclor 1242 is used in carbonless copy paper.

Q. Do you know when the last time it was that Mont -- that NCR made carbonless copy paper using PCBs?

A. I don't know the exact year.

Q. I want you to assume it's 1971.

A. That seems reasonable.

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Q. So that would be -- okay.

So that would be about a half a century ago?

A. Yes.

Q. Do you know anything about recycled paper and how many times paper can be recycled?

A. I know a little bit.

Q. Okay. How many times can paper be recycled?

A. I know that in one of the expert reports that I reviewed it said five to seven times.

Q. Okay. Do you know if it is at all possible that -- well, strike that.

With each of these five to seven times re -- recycling, would it be fair to say, conclude, that in each new recycling of this hypothetical NCR paper, the PCB concentrations in the resulting product would be lower, diluted; correct?

MR. LAND: Objection, calls for speculation, lacks foundation.

THE WITNESS: I really don't know.

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expert reports.

MR. GOUTMAN: This is Exhibit --

MR. SORENSON: 29.

MR. GOUTMAN: -- 29.

(Exhibit Rodenburg-29, one-page document entitled Inland Empire Paper Company, PCB Fact Sheet, is marked for identification.)

BY MR. GOUTMAN:

Q. I've marked as Exhibit 29 an Inland Empire Paper PCB Fact Sheet.

I take it you haven't seen this before?

A. I don't think so.

Q. And it says that, "IEP was a PCB-free mill prior to 1991.

"It was only after IEP began to recycle in 1991 that PCBs were discovered in its effluent."

Is that what it says?

A. That's what it says.

Q. And it says, "PCBs originate from inks in the recycled paper is a byproduct of their manufacturing process."

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Is that what it says?

A. That's what it says.

Q. So you are contending that it's not from the inks, it's from recycled NCR paper that hasn't been manufactured since 1971; is that correct?

A. I said that the main source, the main thing that accounts for the fingerprint looks like Aroclor 1242/1016.

Q. Going back to Exhibit 28, which is the life cycle of recycled paper, it says -- I'm sorry, Page 17 under 1.5.3, "Unlike some other materials that can be recycled an infinite number of times, paper can only be recycled between five and seven times. The fibers in the paper get shorter each time they are recycled, eventually becoming too short to be made into new paper."

Is that what it says?

A. Yes.

Q. Do you have any reason to dispute that?

A. No.

Q. Sorry.

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Do you know if -- do you have any evidence that IE -- IEP ever used NCR paper in its recycling process?

A. I have no idea.

(Counsel confer.)

(Exhibit Rodenburg-30, letter dated March 23, 2015 addressed to Ms. Cheryl Niemi, is marked for identification.)

BY MR. GOUTMAN:

Q. I'm showing you as Exhibit 30 correspondence from Mr. Krapas dated March 23, 2015 directed to an official at the Washington Department of Ecology; correct?

A. Correct.

Q. And it says in the second paragraph, "IEP is one of the few remaining pulp and paper mills in the State of Washington that use -- uses recycled paper products. IEP does not produce polychlorinated biphenyls (PCBs) in its manufacturing process, but does have to address the presence of PCBs in the inks and dyes contained in the recycled paper stock used at its mill."

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to Ecology; correct?

A. Their fact sheet says that PCBs originate from inks and -- so that is one source. Again, I don't see anywhere in here where it says that that is the only source of PCBs to their facility.

Q. It says that it was a PCB-free mill prior to 1991; correct?

A. Yes.

Q. And that -- and that only after it started to recycle paper were PCBs discovered. That's what the fact seat -- feet -- sheet says; right?

A. Yes.

Q. And it says PCBs originate from inks in the recycled paper as byproduct of their manufacturing processes; correct?

A. That's what it says.

Q. And it says -- and the letter to Ecology says that the presence of PCBs in the inks and dyes contained in recycled paper stock; is that correct?

A. That's what it says.

Q. Let me ask you this. Are you

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aware of any document anywhere in the universe in which IEP has stated that PCBs come from anywhere other than inks and dyes in recycled paper stock?

A. No.

MR. GOUTMAN: I want to show you a report. Why don't we mark this first.

(Exhibit Rodenburg-31, multipage document entitled Inadvertent PCBs in Pigments: Market Innovation for a Circular Economy Final Report, is marked for identification.)

BY MR. GOUTMAN:

Q. I've handed you Exhibit 31, which is a report prepared on behalf of the Task Force by Northwest Green Chemistry, October 16th, 2018 titled, "Inadvertent PCBs in Pigments: Market Innovation For a Circular Economy"; is that correct?

A. Correct.

Q. Prepared by a Dr. Heine, H-E-I-N-E; correct?

A. Correct.

Q. And I want to direct your

attention to Page 17 of this document, and specifically to the last paragraph second sentence. Does it not say, "Inadvertent PCBs in the recycler's effluent correlated with PCBs in pigments used on the paper products they recycle, such as newspapers, magazines, mailing materials and packaging"?

Did I read that correctly?

A. Yes.

Q. I want to move on to the next subject addressed in your report, Page 38, which is surface water CLAM samples.

A. Yes.

Q. And am I correct that the R2 values in those samples are all under 9 -- .9?

A. When the PCB-7 is included, the R --

(Reporter clarification.)

A. Sorry. When PCB-7 is included in the regression, the R2s ranged from .14 to .55. And when this congener is excluded, they were from .71 to .83. So your question, I believe, was whether they are less than .9?

Q. Yes.

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A. So usually when you get the data, there's a column in the spread -- or the database that's called "Laboratory Qualifier," and that will have usually a letter code, sometimes a numerical code, and those flags can mean a lot of different things.

Q. Right. So, for example, in this data there were "B" flags, were there not?

A. I don't remember.

Q. Well, a "B" flag means that the associated blank has also detected the particular congener; right?

A. Correct.

Q. Am I correct that in your analysis you performed no blank correction of any "B" flag data?

A. For the municipal products, no, I did not.

(Counsel confer.)

MR. GOUTMAN: So we'll mark this as 32.

(Exhibit Rodenburg-32, multipage document, Line 1 entitled City Of Spokane PCB Product Testing Results, is marked for

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identification.)

MR. GOUTMAN: And we'll mark this as 33.

(Counsel confer.)

MR. GOUTMAN: And I'll represent to you that this is your data compilation, but first 32 is the raw data and the second, Exhibit 33, is the process data. Okay?

THE WITNESS: I only have the 32.

MR. GOUTMAN: I'm sorry. I was yammering when -- no, no, it's okay.

(Exhibit Rodenburg-33, multipage document Line 1 entitled City Of Spokane PCB Product Testing Results, is marked for identification.)

BY MR. GOUTMAN:

Q. Ready to go?

A. Yes.

Q. So on 32, you can see there's synthetic motor oil, Line 14.

A. Yes.

Q. And that is...

(Counsel confer.)

Q. So this is analysis of the

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synthetic motor oil, these pages; correct?

A. (No reply.)

Q. And you're looking at each of the congeners; right?

A. Yes, it's some things including the synthetic motor oil.

Q. Okay. Well, I'm just looking at -- at -- I'm sorry -- AY and AZ, Columns AY and AZ, all right? That would be synthetic motor oil?

A. Yes.

Q. And if you go to Line 62, that is flagged as "BJ"; correct?

A. Correct.

Q. And that means what?

A. The "B" means that it was -- that congener was also present in the blank.

Q. And "J" means?

A. I believe "J" means that it's a value between the lowest analyzed standard and the detection limit.

Q. It says here in this document the value is less than the minimum calibration level but greater than the estimate.

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A. Yeah, that's basically what I just said.

Q. Okay. All right. Now, if you look at the process data, 33, for, again, for synthetic motor oil, Line 62 -- I'm sorry. If you go back to 32, Line 62, you're looking at PCBs 52 and 69; right? And that's the raw data.

A. Line 62, 52 and 69, yes.

Q. Okay. If you go to the process data, Line 62 is, again, Aroclors 52/69?

A. PCBs, yes, PCBs 52 and 69.

Q. Am I correct that you indicate a concentration, correct, as having been detected?

A. Yes.

Q. And so you say "TRUE."

A. Yes.

(Counsel confer.)

Q. Okay. So am I correct that when the City -- that the City in its report when it looked at "B" flag data, it reported the samples of "B" flag data as non-detect; correct?

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A. I don't know.

(Exhibit Rodenburg-34, multipage document entitled PCBs in Municipal Products Revised, is marked for identification.)

BY MR. GOUTMAN:

Q. So I've handed you as Exhibit 34 PCB -- PCBs in Municipal Products prepared by the City of Spokane, July 21, 2015; correct?

A. Correct.

Q. And if you turn to the second to last page -- I'm sorry -- Page 5, Page 5 --

A. Yes.

Q. -- under "Laboratory Quality Control," second paragraph, it states that, [as read]: "PCBs are frequently detected in blank samples. To account for this, any congener that was detected in a product sample that was within three times the concentration detected in the associate blank sample was removed from the total PCB value"; is that correct?

A. Yes.

Q. You didn't do that; correct?

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A. Correct.

(Counsel confer.)

Q. With respect to "N" flag data, "N" flag means according to Pacific Rim -- Pacific Rim "not detected"; right?

A. I don't know.

(Counsel confer.)

(Exhibit Rodenburg-35, multipage document entitled Sample Receipt Form/Chemical Analysis Form, is marked for identification.)

BY MR. GOUTMAN:

Q. Okay. This is -- we've handed you Pacific Rim's -- sorry -- Methodology, basically PCB SOP for Method 1668; right?

A. I don't know what this is, so...

Q. Look at the second page.

A. Oh, second page. Okay.

And what was your question again?

Q. I've handed you a document that on the second page identifies itself as Pacific Rim's PCB SOP for EPA Method 1668 dated November 6, 2014; right?

A. I -- this is the SOP? 'Cause it

just says it's -- it says, "Reference Method: PCB: SOP." But I don't know, is this the SOP? I don't -- I can't tell.

Q. Well, let's go to Page 5 of 221.

A. My pages are not numbered -- oh, here we go. There -- there are the numbers. Okay.

Q. The top right.

A. Okay.

Q. "The following flags or qualifiers have been used with this data set." That's what it says; right?

A. Yes.

Q. And "N" says, "not detected due to incorrect ion ratio"; right?

A. Yes.

Q. So with that in mind, turn to Exhibit 33 -- I'm sorry. 32. The raw data.

A. Yeah.

Q. Row 55.

A. Yes.

Q. You're looking at PCB-43 and 49 --

A. Yes.

Q. -- for the synthetic motor oil.

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And that has an "NJ" flag, does it not?

A. Yes.

Q. The "N" is not detected; right?

A. Not detected -- well, according to this, an "N" is not detected due to incorrect ratio. And then it says the value reported concentration report is EMPC.

Q. Which means what?

A. I believe that EMP stands for estimated maximum potential concentration.

Q. Right. And so you took this "N" flag data not detected due to ion ratio just giving the maximum potential, and in Exhibit 33, Line 55 are these same congeners that were flagged as not detected. You report that they are detected and you just report "true"; correct?

A. Yes.

Q. At the maximum -- excuse me, estimated maximum possible concentration of .0603; correct?

A. Yes.

Q. Oh, why don't we -- if you can go

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A. (The witness complies.)

Q. That reports the results of PCB-11; correct?

A. Correct.

Q. And it says that its concentration is 8.46?

A. You're looking at the yellow road tape?

Q. Yeah.

A. Yes.

Q. Okay. If we look at your process data for PCB-11, it has -- at Line 25 it has a concentration of .46, not 8.46; correct?

A. That's what it says.

Q. So you essentially lopped off the first digit; correct?

A. Well, let me -- I don't know how that happened.

Q. Okay. In any event, when the raw data is processed such that the concentration is diminished by approximately a factor of what, 8, that would -- that would bring into question the validity of the analysis; correct?

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MR. LAND: Objection, vague, incomplete hypothetical.

Go ahead.

BY MR. GOUTMAN:

Q. There's a pending question.

A. I'm lost. Can you repeat the question?

Q. I'm sorry. When the raw data is reported -- is one thing, and then it is processed and misreported, that would affect the validity of the analysis; correct?

A. Depends on how big the error is.

Q. Well, in this case, the concentration was diminished from 8.46 to .46; correct?

A. Correct.

Q. And what's that a factor of --

A. 16.

Q. -- 16?

So your -- in your analysis, the concentration of the byproduct PCB Congener 11 was diminished by a factor of 16 simply because you lopped off a decimal; correct?

A. Correct. Well, again, not me. I

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don't know what happened. I didn't specifically do it, but something happened in the spreadsheet.

Q. Okay. Let me just -- do you know why that happened?

A. No.

Q. It appears to me that in the transcription of the data from raw to processed, any number to the left of the decimal point was removed.

Is that possible?

A. That's what appears to have occurred in this case.

Q. Okay.

(Counsel confer.)

Q. So could you take out PCBs in Municipal Products again, Exhibit 34. You see that?

A. Yes.

Q. Can you go, please, to Table B-1?

A. What page is that on?

Q. I'm sorry. It's second to last page.

A. Yeah. Got it.

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CERTIFICATE

COMMONWEALTH OF PENNSYLVANIA)
) ss:
COUNTY OF PHILADELPHIA)

I, Debra Sapio Lyons, a Registered Diplomat Reporter, a Certified Realtime Reporter, a Certified Realtime Captioner, an Approved Reporter of the United States District Court for the Eastern District of Pennsylvania, a Certified Court Reporter for the State of New Jersey; and Notary Public within and for the States of New Jersey, New York and the Commonwealth of Pennsylvania do hereby certify:

That Lisa A. Rodenburg, Ph.D., the witness whose deposition is hereinbefore set forth, was duly sworn by me and that such deposition is a true record of the testimony given by such witness, to the best of my ability and thereafter reduced to typewriting under my direction.

I further certify that I am not related to any of the parties to this action by blood or marriage and that I am in no way interested in the outcome of the matter.

In witness whereof, I have hereunto set my hand this 23rd day of December, 2019.

Debra Sapio Lyons

____
DEBRA SAPIO LYONS
CRR, RDR, CRC, CCR, CPE

Errata to

Fingerprinting of PCB congener patterns in samples from the Spokane, WA area

Lisa A. Rodenburg

January 8, 2020

During the deposition regarding my expert report dated October 11, 2019, Defendants' counsel noted some minor errors in my analysis of over 150,000 data points related to PCBs in the Spokane River valley. The purpose of this report is to fix those errors. **After careful examination, I conclude that these minor errors have no impact on the conclusions of my report.**

Truncation of data in the Spokane consumer products data

The City of Spokane conducted a study in which PCBs were measured in a variety of consumer products (City of Spokane Wastewater Management Department, 2015). During my analysis of this data, I mistakenly truncated some of the numbers, converting, for example, 63.8 to 3.8. Out of 29,847 data points, this error affected 110, or 0.37% of the data. These data points affected thirteen samples, listed in Table 1. **These errors had no effect on the conclusions of the report.** If anything, the newly corrected data displays better correlations between the congener patterns of the Aroclors and those of the consumer products.

I interpreted the data such that when the agreement (R^2) between a fingerprint and a single Aroclor was greater than approximately 0.8, the factor was considered to represent an unweathered single Aroclor. When the agreement was between approximately 0.4 and 0.8, the fingerprint was interpreted as representing a weathered Aroclor. Under this interpretation, the changes in the R^2 values were not significant (i.e. they did not move the sample from one category to another) for 11 of the 13 samples. For the remaining two samples, the R^2 value actually improved and changed the interpretation toward a closer match between the Aroclor and the sample. For the hydroseed (sample ID 028-100214-1515), the R^2 increased to 0.9 from 0.59, putting it now in the category of representing an unweathered Aroclor. For the CaCl deicer (sample ID V310-021616-1415), the R^2 value increased to 0.45 from 0.12, moving this sample into the category of representing a weathered mix of Aroclors.

Table 1. Changes to results of the consumer products data analysis

Sample ID	Sample number	Old R2	New R2
Short Liner	031-100314-1330	0.86	0.84
hydroseed	028-100214-1515	0.59	**0.90**
MgCl Deicer LAB DUP	B6C0121-DUP1	0.31	0.15
WSDOT Salt Brine Soln. LAB DUP	B6C0153-DUP1	0.2	0.19
CaCl Deicer FIELD DUP	Replicate #2	0.18	0.16
CaCl Deicer	V310-021616-1415	0.12	**0.45**
WSDOT Salt Brine Soln.	V313-022316-1018	0.12	0.19
dust suppressent	023-101014-1035	0.08	NS
yl rd paint (sherwin)	002-082514-1039	NS	NS
spray paint (green)	006-082714-1045	NS	NS
portfolio 4f (pesticide)	013-091814-0940	NS	NS
yl rd paint (ennis) duplicate	replicate #2	NS	NS
Enis-Flint White Road Paint Duplicate	Replicate #2	NS	NS

NS = Not significant

Multiple Linear Regression (MLR) results

The Python code used to conduct the multiple linear regressions had an error that allowed Aroclor 1242 to be included as a significant Aroclor for some of the environmental samples even though the coefficient for Aroclor 1242 was either not positive or not significant. For these samples, Aroclor 1242 was not a significant contributor to the congener pattern, but the other Aroclors were correctly listed as significant, and the R^2 values changed very little. **Therefore this error had no effect on the conclusions of the report.** The revised results are given in Table 2. As noted above, I interpreted the data such that when the agreement (R^2) between a fingerprint and a single Aroclor was greater than approximately 0.8, the factor was considered to represent an unweathered single Aroclor. When the agreement was between approximately 0.4 and 0.8, the fingerprint was interpreted as representing a weathered Aroclor. Under this interpretation, the R^2 value decreased significantly for only one of the affected samples: For river sediment sample 1304017-03, the R^2 value dropped to 0.78 from 0.83. The R^2 = 0.8 cutoff is approximate, but this does move the sample from the category of representing unweathered Aroclors to representing weathered Aroclors. The R^2 value actually increased for a sample of biofilm analyzed in duplicate from below 0.4 to slightly above 0.4, moving this sample into the category of representing a mix of weathered Aroclors. The R^2 value also increased for the biofilm sample from TJ Meenhach to 0.81 from 0.79. Again, the 0.8 cutoff is approximate, but this sample does technically move from the weathered Aroclor to the unweathered Aroclor category.

Table 2. Revised MLR results for environmental samples

Matrix	StudyID (BB v20)	Location	Sample ID	Column	Number of peaks used	Detected peaks	New R2	New R2 w/o PCB 11	Aroclor			PCB 11	PCB-209	Data source	Old R2
Atmospheric deposition	BERA0013	Turnbull	1611056-3	SPB-octyl	148	32	NS					12%	0%	SRRTTF	0.14
Biofilm	Biofilm	Barker Bridge (RM 90.4)	BB (1809040-03)	SPB-octyl	152	75	0.91	0.91	1248	1254	1260	0%	1.80%	SRRTTF	0.91
Biofilm	Biofilm	GE Mission Left Bank (RM 78.7)	GEM-LB (1809040-07)	SPB-octyl	152	123	0.91	0.93	1248	1254	1260	2.5%	0.11%	SRRTTF	0.90
Biofilm	Biofilm	GE Mission Right Bank (RM 78.7)	GEM-RB (1809040-08)	SPB-octyl	152	120	0.64	0.82	1248	1254	1260	8.6%	0.18%	SRRTTF	0.55
Biofilm	Biofilm	Green Street Left Bank (RM 78.0)	GR-LB (1809040-09)	SPB-octyl	152	119	0.79	0.94	1248	1254	1260	6.2%	0.20%	SRRTTF	0.79
Biofilm	Biofilm	Green Street Right Bank (RM 78.0)	GR-RB (1809040-10)	SPB-octyl	152	121	0.76	0.89	1248	1254	1260	6.2%	0.18%	SRRTTF	0.76
Biofilm	Biofilm	Gonzaga (RM 75.0)	GZ-BF-DUP (1809040-21)	SPB-octyl	152	135	0.61	0.61	1248		1260	1.3%	0.06%	SRRTTF	0.80
Biofilm	Biofilm	Hangman Creek (RM 0.8)	HM-BF (1809040-16)	SPB-octyl	152	112	0.90	0.90	1248	1254	1260	0%	0.32%	SRRTTF	0.94
Biofilm	Biofilm	Mission Bridge (RM 76.6)	MIB (1809040-11)	SPB-octyl	152	139	0.89	0.91	1248	1254	1260	2.40%	0.25%	SRRTTF	0.86
Biofilm	Biofilm	Monroe Bridge (RM 73.8)	MOB (1809040-14)	SPB-octyl	152	118	0.90	0.95	1248	1254	1260	3.8%	0.29%	SRRTTF	0.90
Biofilm	Biofilm	Nine Mile Dam (RM 57.7)	NMD (1809040-19)	SPB-octyl	152	112	0.78	0.94	1248	1254	1260	7.0%	0.32%	SRRTTF	0.78
Biofilm	Biofilm	Plantes Ferry-Biofilm (RM 84.8)	PF-BF (1809040-05)	SPB-octyl	152	117	0.92	0.92	1248	1254	1260	0%	0.14%	SRRTTF	0.92
Biofilm	Biofilm	Spokane Gage (RM 72.7)	SG (1809040-15)	SPB-octyl	152	125	0.97	0.98	1248	1254		1.9%	0.16%	SRRTTF	0.97
Biofilm	Biofilm	Stateline (RM 95.9)	SL (1809040-01)	SPB-octyl	152	83	0.90	0.90	1248	1254	1260	0%	1.84%	SRRTTF	0.90
Biofilm	Biofilm	Seven Mile Bridge (RM 62.0)	SMB (1809040-18)	SPB-octyl	152	112	0.50	0.93		1254	1260	13%	0.63%	SRRTTF	0.50
Biofilm	Biofilm	TJ Meenach (RM 69.9)	TJM (1809040-17)	SPB-octyl	152	97	0.81	0.89	1248	1254	1260	5.4%	0.93%	SRRTTF	0.79
Biofilm	Biofilm	Upriver Dam (RM 79.8)	URD (1809040-06)	SPB-octyl	152	122	0.47	0.82	1248	1254	1260	13%	0.21%	SRRTTF	0.39
Biofilm	Biofilm	Upriver Dam (RM 79.8)	URD-DUP (1809040-20)	SPB-octyl	152	120	0.41	0.79	1248	1254	1260	14%	0.21%	SRRTTF	0.35
River sediment	BERA0009	9MD-SEDT	1304017-01	SGE-HT8	174	109	0.87		1248	1254	1260	0.97%	0.37%	SRRTTF	0.89
River sediment	BERA0009	UPRD-SEDT	1304017-02	SGE-HT8	174	112	0.81		1248	1254		0.77%	0.14%	SRRTTF	0.85
River sediment	BERA0009	UPRD-SEDT	1304017-03	SGE-HT8	174	108	0.78		1248	1254	1260	1.2%	0.11%	SRRTTF	0.83
River sediment	BERA0009	9MD-SEDT	1304017-04	SGE-HT8	174	105	0.84		1248	1254	1260	1.1%	0.25%	SRRTTF	0.87
River sediment	BERA0009	9MD-SEDT	1306061-01	SGE-HT8	174	99	0.81		1248	1254	1260	0%	0.25%	SRRTTF	0.85
River sediment	BERA0012	LFP SedTraps	1606061-1	SPB-octyl	148	134	0.94		1248	1254	1260	0.53%	0.36%	SRRTTF	0.95
River sediment	BERA0012	LFP SedTraps	1606061-2	SPB-octyl	148	139	0.91		1248	1254	1260	0.98%	0.42%	SRRTTF	0.94
River sediment	BERA0012	LFP SedTraps	1606061-3	SPB-octyl	148	144	0.91		1248	1254	1260	0.57%	0.28%	SRRTTF	0.93
River sediment	BERA0012	LFP SedTraps	1606061-4	SPB-octyl	148	144	0.92		1248	1254	1260	0.54%	0.31%	SRRTTF	0.94
River sediment	BERA0012	LFP SedTraps	1606061-5	SPB-octyl	148	141	0.91		1248	1254	1260	0.58%	0.33%	SRRTTF	0.94
River sediment	Biofilm	Gonzaga-Sediment (RM 75.0)	GZ-SED (1809040-23)	SPB-octyl	152	138	0.99	0.99		1254	1260	0.05%	0.05%	SRRTTF	0.99
River sediment	Biofilm	Gonzaga-Sediment (RM 75.0)	GZ-SED-DUP (1809040-25)	SPB-octyl	152	136	0.99	0.99		1254	1260	0.08%	0.07%	SRRTTF	0.98
River sediment	Biofilm	Plantes Ferry-Sediment (RM 83.4)	PF-SED (1809040-24)	SPB-octyl	152	131	0.77	0.77	1248	1254	1260	0.07%	0.23%	SRRTTF	0.78
River sediment	DSER0010	LongLkMid	3454111	SPB-octyl	101	74	0.85		1248	1254	1260	0%	0.32%	SRRTTF	0.85
River sediment	DSER0010	LongLkLow	3454112	SPB-octyl	101	77	0.85		1248	1254	1260	0%	0.29%	SRRTTF	0.85
River sediment	DSER0010	LongLkLow	3454114	SPB-octyl	101	74	0.83		1248	1254	1260	0%	0.28%	SRRTTF	0.83
River sediment	DSER0010	LongLkUp	4208147	SPB-octyl	101	98	0.89		1248	1254	1260	0%	0.24%	SRRTTF	0.89
River sediment	DSER0010	SPOK-1	3458100-S	SPB-octyl	101	53	0.73		1248	1254	1260	0%	0%	SRRTTF	0.74
River sediment	SRUWSpok	Spokane River downstream of Upriver Da	1308073-01	SGE-HT8	177	108	0.63		1248	1254		1.4%	0.11%	SRRTTF	0.65
River sediment	SRUWSpok	Spokane River downstream of Upriver Da	1308073-01REX	SGE-HT8	177	71	0.55		1248			1.8%	0.35%	SRRTTF	0.77
River sediment	SRUWSpok	Spokane River dwnstrm of Upriver Dam	1308073-02	SGE-HT8	177	108	0.70		1248		1260	0.94%	0.06%	SRRTTF	0.70
River sediment	SRUWSpok	Spokane River near Iron Bridge	1308073-03	SGE-HT8	177	125	0.78		1248	1254	1260	0.60%	0.20%	SRRTTF	0.78
River sediment	SRUWSpok	Spokane River near Iron Bridge	1308073-03REX	SGE-HT8	177	89	0.82		1248	1254	1260	0.53%	0.09%	SRRTTF	0.86
River sediment	SRUWSpok	Spokane River near Centennial Trail	1308073-04	SGE-HT8	177	142	0.75		1248	1254	1260	0.24%	0.14%	SRRTTF	0.76
River sediment	SRUWSpok	Spokane River downstream of Upriver Da	1308073-06REX	SGE-HT8	177	76	0.89		1248	1254	1260	1.0%	0.002%	SRRTTF	0.90
River sediment	SRUWSpok	Spokane River near Hamilton	1308073-13	SGE-HT8	177	136	0.87		1248	1254	1260	0.15%	0.10%	SRRTTF	0.88
River sediment	WHOB003	Union Gospel Mission Dock	1606035-20	SPB-octyl	149	137	0.96		1248	1254	1260	0%	0.31%	SRRTTF	0.96
River sediment	WHOB003	Union Gospel Mission Dock	1606035-21	SPB-octyl	149	135	0.96		1248	1254	1260	0%	0.28%	SRRTTF	0.96
River sediment	WHOB003	Union Gospel Mission Dock	1702027-26	SPB-octyl	149	133	0.95		1248	1254	1260	0.86%	0.37%	SRRTTF	0.95
River sediment	WHOB003	Union Gospel Mission Dock	1702027-27	SPB-octyl	149	135	0.85		1248	1254	1260	0.75%	0.43%	SRRTTF	0.85
Storm drain solids	SRUW-Libe	WESTLL-Zone2	8444381	SGE-HT8	108	69	0.84			1254	1260	1.7%	0.53%	BB v20	0.87
Storm drain solids	SRUW-Spo	HoganF	1207107-02	SPB-octyl	159	142	0.87			1254	1260	0.25%	0.11%	BB v20	0.89
Tissue	Biofilm	GE Mission Left Bank caddis fly larvea	GEM-INVERT (1809040-29)	SPB-octyl	152	121	0.52	0.52	1248	1254	1260	0%	0.02%	SRRTTF	0.51
Tissue	Biofilm	Spokane Gage (RM 72.7)	SG-INVERT (1809040-28)	SPB-octyl	152	140	0.87	0.87		1254	1260	0.23%	0.03%	SRRTTF	0.88
Tissue	Biofilm	Spokane Gage (RM 72.7)	SG-INVERT-DUP (1809040-30)	SPB-octyl	152	137	0.88	0.88		1254	1260	0.24%	0.03%	SRRTTF	0.88
Treated effluent	CityOfSpok	Spokane City WWTP	L2046716-6	SPB-octyl	120	104	0.42	0.98		1254		4.7%	0.11%	BB v 20	0.31
Treated effluent	CityOfSpok	Spokane City WWTP	L2195827-2	SPB-octyl	120	97	0.73	0.77	1248	1254	1260	3.6%	0.06%	BB v 20	0.62
Treated effluent	CityOfSpok	Spokane City WWTP	PR162811	SGE-HT8	75	57	0.63	0.63	1248	1254	1260	10%	0%	BB v 20	0.48
Treated effluent	CityOfSpok	Spokane City WWTP	PR171292	SGE-HT8	75	46	0.49	0.49	1248		1260	8%	0.78%	BB v 20	0.23

This same error affected five samples from the MLR analysis of the municipal products. These are shown in Table 3. The only significant change is that the yellow road tape (sample ID 034-091014-1328) moves from the 'weathered Aroclor' category to the 'not similar to any Aroclor' category.

Table 3. Revised MLR results for municipal product samples

Sample ID	Description	New R2	Old R2	Aroclors	
017-082614-1400	syn. motor oil	0.43	0.44		1260
022-092914-124	Lignosulfonate (dust sup.)	0.75	0.75	1254	1260
034-091014-1328	yl rd tape	NS	0.45		
P302-010716-1030	CaCl Deicer	0.39	0.40	1254	1260
Replicate #3	WSDOT Salt Brine Soln. FIELD DUP	0.56	0.56	1254	

Non-detect flags for municipal products data

A small number of the municipal product samples (9) were analyzed by Vista Labs. This laboratory appears to have used a different convention for flagging non-detect data. Whereas for the other municipal product data, non-detects were flagged with a U code, it appears that Vista Labs gave the detection limit preceded by a "<" symbol in the concentration field but gave no letter code in the 'Flag' field in the data sheets. In the original treatment of this data, I treated all data for which there was no U code as detected. However, upon further examining this data, the better approach would be to treat a sample with no flag code and a result preceded by a "<" symbol as non-detect (i.e. substitute with zero). I reanalyzed these nine samples accordingly. (Note that data with an 'N' flag was treated as detected. The N flag indicates that the result is an estimated maximum possible concentration (EMPC), i.e. a result greater than the detection limit but less than the limit of quantitation.) The results are shown in Table 4. Where the changes are significant via the criteria outlined above, they all involve an increase in the similarity between the congener profile in the municipal product and the congener profiles of the Aroclors. The R^2 values for six of the nine products increase to greater than 0.4, putting them in the category of 'weathered Aroclors'.

Table 4. Reanalysis of Vista Labs Municipal Product data.

Description	Sample ID	R2 new	R2 old	Aroclors				Conc.	Units
MgCl Deicer	V309-021016-0910	NS	0.31				1260	0	pg/L
MgCl Deicer LAB DUP	B6C0121-DUP1	0.08	0.31	1242		1254	1260	125	pg/L
CaCl Deicer	V310-021616-1415	0.77	0.12				1260	3037	pg/L
WSDOT Salt Brine Soln.	V313-022316-1018	0.41	0.12				1260	0.035	ug/Kg
WSDOT Salt Brine Soln. LAB DUP	B6C0153-DUP1	0.29	0.20				1260	0.023	ug/Kg
COS Road Salt	V311-021616-1435	0.71	0.31	1242		1254	1260	0.083	ug/Kg
Sand (Road Traction)	V312-021616-1430	0.47	0.32	1242		1254	1260	2262	pg/L
Sand (Road Traction) LAB DUP	B6C0145-DUP1	0.68	0.34				1260	1714	pg/L
WSDOT NaCl salt	V314-022316-1030	0.49	0.31	1242	1248	1254	1260	0.048	ug/Kg

References

City of Spokane Wastewater Management Department, 2015. PCBs in Municipal Products REVISED. Spokane, WA.

Lisa Rodenburg

UNITED STATES DISTRICT COURT

SOUTHERN DISTRICT OF CALIFORNIA

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SAN DIEGO UNIFIED PORT DISTRICT, a
public corporation; and CITY OF
SAN DIEGO, a municipal corporation,

Plaintiff, Case No.

vs. 3:15-cv-00578-WQH-AGS

MONSANTO CORPORATION, SOLUTIA INC.
and PHARMACIA CORPORATION,

Defendant.

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DEPOSITION OF LISA A. RODENBURG, Ph.D.

Parsippany, New Jersey

June 14, 2019

Reported by:
MARY F. BOWMAN, RPR, CRR
JOB NO. 161636

recall specifically withholding?
A. No.
Q. I take it then that the documents provided, if you know, the documents provided to us by counsel yesterday -- yesterday or Wednesday? Wednesday -- constitute all of the documents that you turned over to him? Do you know that?
A. I don't really know that for a fact.
MR. LAND: They are, I will attest that they are.
Q. Did you agree with me that there are PCBs present in the environment that were not manufactured by Monsanto?
A. Yes.
Q. And would you agree with me that some of those PCBs are sometimes referred to as inadvertent or byproduct PCBs?
A. Yes.
Q. And if I referred to those PCBs as byproduct PCBs, you will understand that that's the same thing as an inadvertent PCBs?
A. Yes.

Q. So we don't misunderstand each other.
Those PCBs are created during various manufacturing processes, correct?
A. Yes.
Q. And the necessary conditions include the presence of chlorine carbon and heat, correct?
A. I think there may be other conditions, but those conditions will produce PCBs.
Q. Now, as a result of these miscellaneous chemical processes that produce byproduct PCBs, they're found in numerous products, correct?
A. Yes.
Q. Including products that are routinely sold to consumers, correct?
A. Yes.
Q. And one of the main sources of these PCBs are dyes, correct?
A. Pigments.
Q. Pigments, excuse me.
And most of those pigments for the past few decades have been manufactured

pigments in plastics." Correct?
A. Yes.
Q. "From 26 countries and five continents," correct?
A. Correct.
Q. "Washing of clothing introduces PCBs to waste water," is that what you wrote?
A. Correct.
Q. And that's a fact, isn't it?
A. As far as I know, yes.
Q. All of this is as far as you know, you understand that?
A. Yes.
Q. If you look at the figure on this slide, it indicates that PCBs, byproduct PCBs have been found in brown cardboard, right?
A. Yes.
Q. Color glossy magazine, right?
A. Yes.
Q. Color newspaper?
A. Yes.
Q. Yellow cereal box?
A. Yes.

Q. Yellow plastic bag?
A. Yes.
Q. Yellow sticky note?
A. Yes.
Q. It's been found in all kinds of countries, right? Georgia?
A. Yes.
Q. Which used to be part of the Soviet Union?
A. Yes.
Q. It's not like Atlanta, Georgia, correct?
A. Yes.
Q. Moldova, M-O-L-D-O-V-A, right?
A. Yes.
Q. China?
A. Yes.
Q. In fact, there is a lot of recent literature on the existence of byproduct PCBs in various environmental matrices in China, correct?
A. Correct.
Q. You're familiar with the papers?
A. I don't know which specific papers you are referring to, but I'm

familiar with some of them.

Q. Costa Rica, correct?

A. Is that -- what's the question?

Q. I'm just reading your slide. Does it say Costa Rica?

A. Yes.

Q. Does that say, was it put there because byproduct PCBs have been found there?

A. In the paper there, yes.

Q. So I'm listing these because you indicated, at least as I interpret this slide, that these are countries where byproduct PCBs have been measured, correct?

A. They are places where I received paper materials and the PCBs were measured in those paper materials.

Q. OK. Czech Republic?

A. Yes.

Q. Ukraine?

A. Yes.

Q. Thailand?

A. Yes.

Q. Netherlands?

A. Yes.

Q. Italy?
A. Yes.
Q. Uzbekistan?
A. Yes.
Q. Argentina?
A. Yes.
Q. Switzerland?
A. Yes.
Q. Spain?
A. Yes.
Q. United Kingdom?
A. Yes.
Q. South Korea?
A. Yes.
Q. Taiwan?
A. Yes.
Q. Sweden?
A. Yes.
Q. India?
A. Yes.
Q. Finland?
A. Yes.
Q. Myanmar?
A. Yes.
Q. Japan?

A. Yes.
Q. Kyrgyzstan, K-Y-R-G-Y-S-Z-S-T-A-N?
A. Yes.
Q. Greece?
A. Yes.
Q. Brazil?
A. Yes.
Q. New Zealand?
A. Yes.
Q. And Monsanto never manufactured PCBs in most of these countries, right?
A. Correct.
Q. In fact, virtually any of them, right?
A. That's my understanding, yes.
Q. Byproduct PCBs have been found in kid's socks, right?
A. Yes.
Q. A woman's tank top?
A. Excuse me?
Q. Yes?
A. Sorry. Yes.
Q. Woman's tank top.
Kid's white sweatshirt?

A. Yes.
Q. Kid's pink knit shirt?
A. Yes.
Q. Kid's pink sock?
A. Yes.
Q. Kid's yellow sock?
A. Yes.
Q. Kid's green sock?
A. Yes.
Q. A dishwash cloth?
A. Yes.
Q. Kid's pajama back?
A. Yes.
Q. What's a pajama back?
A. The child's pajamas typically have a front and back, and the front will frequently have some sort of printing on it whereas the back will just be a solid color so that's why we tested them separately.
Q. And you found PCBs -- byproduct PCBs on both the front and back?
A. Correct.
Q. You found byproduct PCBs in napkins?
A. Yes.

Q. Kids' handkerchief?
A. Yes.
Q. Kids magic towel?
A. Yes.
(Exhibit 6, document entitled "Inadvertent PCB Production and Its Impact on Water Quality" marked for identification, as of this date.)
Q. So we have placed in front of you another one of your PowerPoints, correct?
A. Correct.
Q. Once again, in this PowerPoint -- do you know who you were addressing here?
A. I don't remember.
Q. In any event, when you present information in this area, inadvertent or byproduct PCBs, you make every effort to ensure that the information you are giving is accurate and correctly reflects the opinions that you hold, correct?
A. Correct.
Q. So in this PowerPoint, if I can direct your attention to page 5, once again it's titled, "PCB 11 concentration and consumer goods." Correct?

talking about when we asked you on page 93 if you were familiar with what we have now marked as Exhibit 10 and you said yes?

A. Yes.

Q. And on the next page, I referred you to pages 46 and 47 of Exhibit 10 and I said that I counted 128 congeners, which were byproduct congeners identified by the document of ecology. And I asked you does that look about right and you said that sounds about right. That was your sworn testimony, correct?

A. Yes.

Q. So going back, you would agree with me that approximately 128 congeners have been identified as byproduct congeners, correct?

A. Approximately, yes, I didn't count them, but yes.

Q. Do you want to count them?

A. Not really.

Q. Take my word for it?

A. I'll take your word for it.

Q. OK, thank you.

We were on Exhibit 8. Could you

get Exhibit 8 back out, Dr. Rodenburg.
MS. YANOCHIK: It's this one --
A. With the no cover page? I wonder what happened to the cover page.
Q. Could you go to page 2169?
A. Yes.
Q. One bullet I would like to read from you, you were talking about PCB 11, correct?
A. Yes.
Q. And you say virtually all of it gets out into the environment, is that what you say here?
A. Yes.
Q. Would you agree with me that inadvertent PCB concentrations in pigments have been identified up to 2500 PPM, parts per million?
A. I'm sorry, wait until we deal with the noise.
Q. Sure.
A. Could you repeat the question?
Q. Sure. Would you agree with me -- and again we went over this with you in Hartford, but we will go over it again.

Would you agree with me in the literature, byproduct PCB concentrations have been documented as being up to 2500 parts per million?

A. That sounds about right, yes.

Q. Why don't we mark this as next exhibit.

(Exhibit 11, transcript dated September 25, 2017 marked for identification, as of this date.)

Q. So we went over this with you in Seattle. Do you recall that? Excuse me, in Seattle?

A. In New Jersey.

Q. That's what it seems like.

In New Jersey in another -- in a case that we took your deposition with last year, correct?

A. That's correct.

Q. We took your deposition last year I should say.

And this was a transcript of a webinar you gave in September of 2017, right?

A. Yes.

CERTIFICATE

STATE OF NEW JERSEY)
)ss:
COUNTY OF UNION)

I, MARY F. BOWMAN, a Registered Professional Reporter, Certified Realtime Reporter, and Notary Public within and for the State of New Jersey, do hereby certify:

That LISA A. RODENBURG, Ph.D., the witness whose deposition is hereinbefore set forth, was duly sworn by me and that such deposition is a true record of the testimony given by such witness.

I further certify that I am not related to any of the parties to this action by blood or marriage and that I am in no way interested in the outcome of this matter.

In witness whereof, I have hereunto set my hand this 19th day of June, 2019.

Mary F. Bowman

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MARY F. BOWMAN, RPR, CRR